POWER

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Cleanliness

IN A recent address a prominent power-plant engineer commented upon the difference between the old-fashioned boiler room, with its piles of coal, ashes and hot clinkers on the firing floor and the air full of soot and coal dust, hot, dark and stuffy, where brawny men passed their lives in discomfort and disorder trying to burn all the coal they could, and the cool, light, clean, modern boiler room where machinery does the work of the husky and white-collar men work with their heads instead of with their hands to see how much coal they can save.

"Put a man into a dirty, uncomfortable place to work," he said, "and you cannot get the same efficiency out of him as in a cleaner, cooler place."

Dirt and clutter beget dirt and slovenliness. One hesitates to throw a cigar stump, fruit peelings, papers, etc., upon a clean, well-kept street or sidewalk, but if clutter is already there he does not stop about adding to it, and so the mess is cumulative.

If cleanliness is the condition to be maintained, it is a good deal easier to maintain it continuously than by spurts. Avoidance of clutter, the habit of picking up a bit of rubbish when one sees it instead of contributing some more, of wiping off a blemish as soon as it appears, will keep things clean and bright with less work than is needed to bring them back when they have become disordered, dull and dirty, and they look like interest and attention and right living instead of slovenliness and neglect.

It is the same with a new tool, a new engine, a new suit. While the shine is on it, the owner is a lot more careful about what he does with and to it than he is after carelessness or accident has produced a blemish or two. And once that carefulness is gone, the deterioration is rapid. Look out for the first laxity—Keep it Clean!

F. R. Low

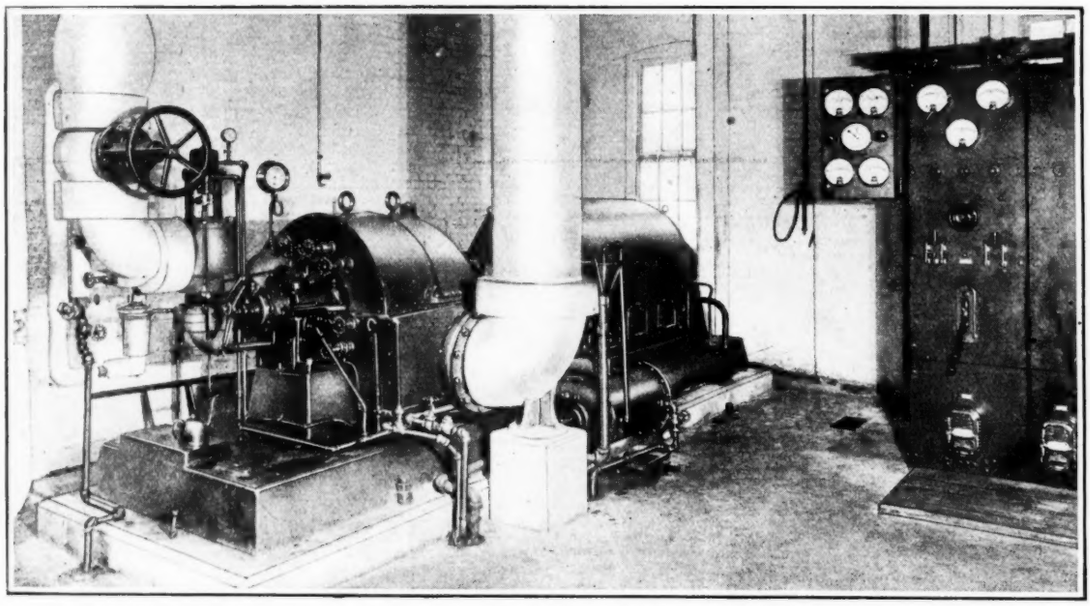

Fig. 1—Non-condensing 500-kw. turbine replaced 150-hp. engine and purchased power

Installing Non-Condensing Turbine Lowers Factory Power Costs

TELLS how factory conditions were analyzed and then improved by substituting a 500-kw. non-condensing turbine set in place of a small engine unit with purchased power and process steam direct from the boiler.

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THE use of low-pressure steam in process work where electrical power is also required, is likely to create a combination of circumstances whereby it becomes economical for the manufacturer to have his own generating plant.

Hat factories, on account of the felting, dying and other operations carried on in them, ordinarily need both low-pressure steam and electrical power for motors, lighting and heating. Recently, the Mallory Hat Company, of Danbury, Conn., which has a yearly production of some 100,000 dozen hats, undertook extensive additions to its plant and at the same time a revamping of its power arrangements, not only from the viewpoint of distribution but also of generation.

Before any changes were recommended or undertaken, careful studies of existing conditions as well as present and possible future requirements were made. On these studies were based calculations of what economies might be effected. At the time the improvements were undertaken there were four electric services entering the plant at different points and a 150-hp. Corliss engine. There was also a boiler plant (10,200 sq.ft.) of ample capacity plus a generous margin for the existing requirements of this engine and the various processes requiring steam.

The object of the studies and calculations was, consequently, to determine whether the Corliss engine could not be discarded and the same boiler plant used to run turbo-generators as reducing valves for the low-pressure process steam and thus secure the electrical power as a byproduct.

The first step was to take graphic wattmeter readings showing the total of the actual electrical loads on the four services and then to summarize them in a single curve as shown in the charts, Fig. 2 and 3. Daily steam consumption, including that required for heating in winter, was also recorded in the form of curves with the aid of flow meters and plotted on the same chart.

This revealed that there was enough steam used for processes, etc., to supply the possible electrical load shown in the curve on the chart, which slightly exceeded the actual power then used, provided the steam could be passed through an engine of sufficiently low water rate. As taken from the steam-consumption curve this rate should be 45 lb. per kw.-hr.

It was found that by using a pressure of 175 lb., which was entirely practicable for the existing boilers, bringing the electrical feeders together at one point and installing a 500-kw. 7-stage turbine designed to operate at this pressure with a back pressure of not more than 10 lb., it would be possible to generate all the electrical energy required in the plant and use the low-pressure steam for process work. The guaranteed

water rate for such a turbine was 40 lb. per kw.-hr. at full load, 43.7 lb. at three-quarters, and 50.5 lb. at half load.

In addition to running new electrical feeders from the new main switchboard to pick up the existing feeders at the entrance points of the four old services, it was also necessary to install a considerable amount of low-pressure steam piping. Careful studies were made showing how to make use of as much of the old piping simultaneously at the four points, on old service entrances, where the original electrical load readings were taken.

It is an instructive commentary on how well, where all factors are given sufficient consideration and weight, a preliminary calculation may agree with actual requirements. In other words, with this new arrangement there is, as calculated beforehand, an installation that provides all the electrical energy and all the exhaust

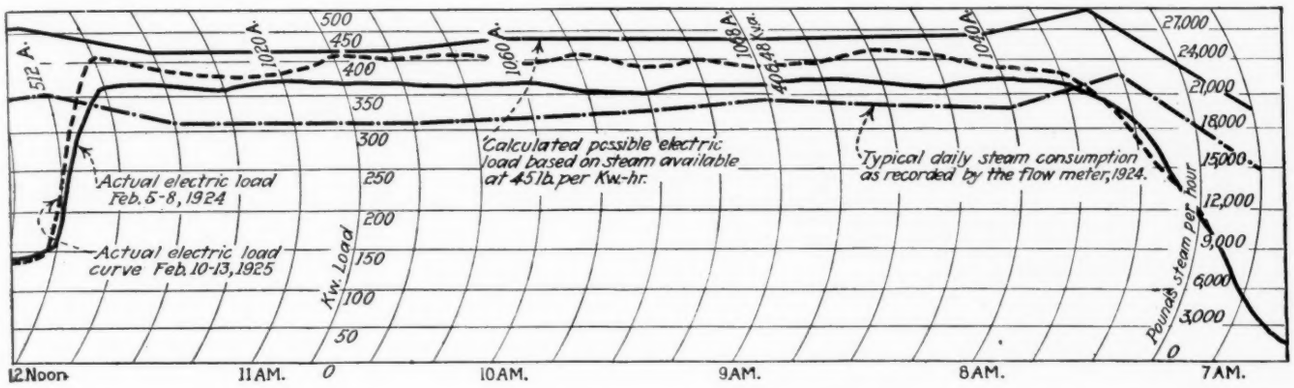

Fig. 2—Actual morning load curves check closely with curve of energy available in supplying exhaust steam

as possible and how to locate valves in such a manner that portions could be isolated for repair work without shutting off unaffected parts of the plant. Valves were also installed with a view to securing maximum economy at night and on holidays or other shutdown periods, so as not to have steam in dead pipes when it was not needed for process work. Drips were also arranged so that the hot water would be returned by means of pumps to an open feed-water heater.

In securing the figures on which this calculation was based, very careful checks were made. For instance, steam required, whereas formerly only the small amount of exhaust from the Corliss engines and a few other small engines for heating and ventilating was used for process work, while practically all the electrical power was purchased.

There was, however, another matter to be taken into account. Under the wide variation of production obtaining in a plant of this kind at various times, it was altogether probable that conditions would arise where the almost perfect balance, normally, of electrical power and process steam would be upset. Consequently, a

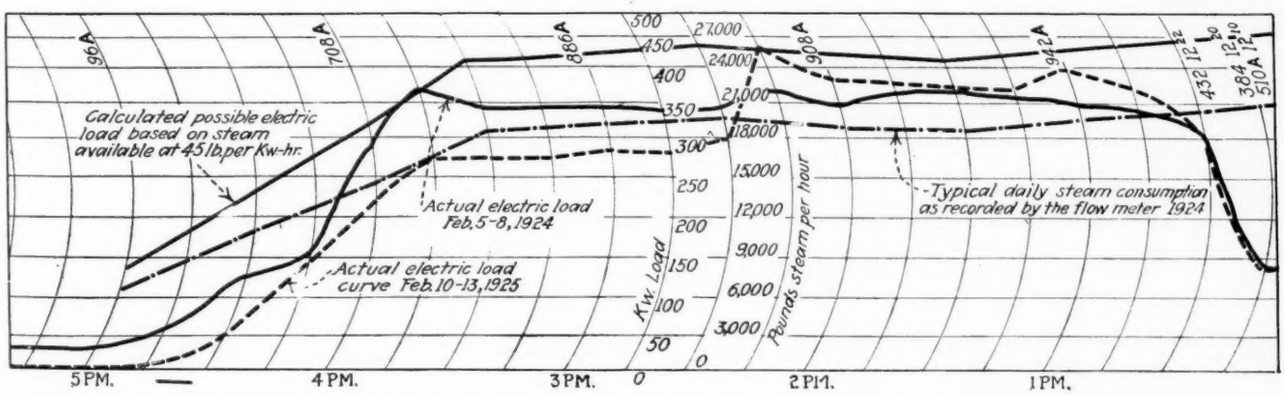

Fig. 3—Curves for afternoon indicate peak electrical loads handled in 1925 are greater than in 1924

steam-flow readings were checked back to coal consumption, water and amount of the plant in service at the time. The electrical readings were tested for accuracy by considering the ratio to total connected loads, amount of plant in service and quantity of production. Then liberal margins were allowed for errors.

The curves in Figs. 2 and 3 show how closely the calculated possible electrical load curve approaches the actual made after the new installation was completed. The latter is the result of adding the readings taken

turbine of sufficiently low water rate was chosen in order to leave a good margin of high-pressure steam available after the electrical requirements had been fulfilled.

In case there should be an insufficient amount of exhaust steam, the piping has been so arranged that the deficiency will be automatically made up by high-pressure steam direct from the boilers passed through reducing valves. On the other hand, it was just as possible that there might not be use for all the waste

steam. In case this contingency develops, arrangements have been made for the convenient installation of a hot-water-storage system, but the actual purchase of this equipment has been postponed.

To help elucidate this point, mechanical time recorders have been installed to indicate the times of opening the relief valve to the atmosphere and of the makeup valves between high- and low-pressure steam. The extent of the opening of these valves will give an approximate indication of the amount of steam so used, which will be desirable as a check on other measurements of this quantity.

An example of how the yearly requirements of electrical energy and process steam worked out is as follows:

Total yearly consumption of electrical energy	650,000 kw.-hr.
Purchased power for out of service periods (lights at night, etc.)	50,000 kw.-hr.
Power to be supplied by turbine	600,000 kw.-hr.
At 45 lb. steam per kw.-hr. this amounts to	27,000,000 lb. steam per year.
At 7 lb. steam per lb. of coal this amounts to	3,857,143 lb. coal per year.
Lb. coal used per year under old system	7,178,000
Lb. coal available for live steam purposes	3,320,857
At 7 lb. steam per lb. of coal this means	23,245,999 lb. steam per year.

By allowing a liberal margin for wastage, auxiliary engines and for the small amount of high-pressure work throughout the plant, something like 10,000,000 lb. of steam was left unaccounted for, which provided a safe surplus for growth and possible error. In addition to this the water rate for the turbine was figured 10 per cent high (it being actually about 40 lb. per kw.-hr.) and the evaporation of the boilers at least 10 per cent low.

Table I was formulated as one of the preliminary steps in calculating the possible savings under a variety of schemes for economizing on the cost of power. The four plans represented by these columns are: (1) Old basis of supplying power and heat; (2) purchasing all power and generating steam for process work; (3) purchasing one-half and generating one-half the power; (4) total power generated with process steam supplied by exhaust.

TABLE I—CALCULATED COSTS OF SUPPLYING POWER AND PROCESS STEAM BY THE ORIGINAL AND OTHER METHODS*

Items	Old Basis	Total Power Purchased	One-half Total Power Purchased	Total Power Generated
Coal per year	$27,000	$27,000	$27,000	$28,000
Water per year	450	450	450	450
Attendance	6,000	6,000	6,000	6,000
Oil, waste, engine supplies	300	100	200	200
Repairs	50	100	200	200
Purchased power	17,500	13,000	6,500	1,500
Interest on investment	.....	540	1,500	1,200
Depreciation	.....	675	1,850	1,500
Taxes	.....	13	37	30
Insurance	.....	22	60	49
Miscellaneous	.....	50	100	100
Total cost per year	$51,300	$47,950	$43,897	$39,229

*Second plan requires transformer substation only as against new substation and generating equipment for third and fourth.

In order to make this yearly saving of $12,000 shown in the last plan over the original, it was necessary to buy the generator equipment, to revamp the electric light and power feeders and the low-pressure steam piping, and to install auxiliaries and feed-water heaters. At the time the construction work was being carried on, it was advisable to take advantage of available outside help for the installation of numerous plant improvements that had been held in abeyance. With the total expenditure for all this work plus a few additional items, the savings accomplished should enable the company to pay for the entire cost in three to four years.

From Table I it can be seen that there is practically no variation in the items among any of the schemes considered in the yearly expenditures for coal, water and attendance. In fact, the only variation of importance is that of the cost of purchased power, which represents the main saving and in a small degree, depreciation and interest on account of the increased capital investment, which represents the principal increase in annual charge against the new installation. Actual observations and measurements made since the new arrangements were put into operation, indicate that the additional increase allowed, of $1,000 per year for coal, was uncalled for.

In fact, figures taken since Jan. 1, 1925, indicate that all the expected savings will be realized and probably more, as during February less coal was burned than in February, 1924, with comparable production and outdoor temperatures.

TABLE II—OPERATING LOG SHEET WITH IMPROVED PLANT

Date Mon. Feb. 9, 1925	Boiler Pressure, Lb. Sq.In. Ga.	Inlet Pressure, Lb. Sq.In. Ga.	Back Press. Lb. Sq.In. Ga.	Nozzles Closed.	Load, kw.	Volts.	Power Factor, per Cent.	Temp. of Outside, Deg. F.	Lb. of Steam One Hr. Through Turbine.	Tons of Coal for Day, (2,000 Lb. per Ton).
8:30 a.m.	173	143	5	..	415	235	86	31	17,300	.....
11:00 a.m.	172	143	6	..	410	235	86	42	17,300	.....
2:00 p.m.	170	140	7	..	395	225	86	45	17,000	.....
3:30 p.m.	168	138	7	..	390	220	88	43	16,800	18.0
Feb. 10, Tues.										
8:20 a.m.	170	154	7	..	415	230	87	41	17,500	.....
11:35 a.m.	169	138	7	..	400	228	88	46	16,800	.....
2:20 p.m.	175	129	7	2	300	230 / 225	87 / 70	..	.....	.....
4:10 p.m.	158	80/105	6	3	150/170	235	75	46	12,000	13.2
Feb. 11, Wed.										
8:45 a.m.	170	149	8	..	405	220	88	48	17,800	.....
3:10 p.m.	169	146	9	..	380	225 / 225	88 / 70	50	17,600	.....
4:30 p.m.	162	68/75	8	4	70/90	235	80	51	4,600	9.6
Feb. 12, Thurs.										
11:00 a.m.	168	148	8	..	405	220	87	41	17,800	.....
4:10 p.m.	172	115	7	3	180	235	78	32	8,700	16.8
Feb. 13, Fri.										
9:45 a.m.	168	145	6	..	405	230	87	40	17,500	.....
3:00 p.m.	172	147	7	..	400	235	87	34	17,700	16.8
Feb. 14, Sat.										
9:00 a.m.	170	145	7	..	405	220	87	40	17,500	.....
11:00 a.m.	170	143	7	..	400	230	87	..	17,300	13.2

TABLE III—SUMMARY OF THREE DAYS' OPERATION

Item	Amount	How Obtained
1. Average 3 day daily evaporation	585,800 lb. water	Meter in feed-water heater.
2. Average 3 day nightly evaporation	158,600 lb. water	Meter in feed-water heater.
3. Average 24 hour evaporation	744,400 lb. water	Adding.
4. Average 24 hour coal burned	81,600 lb. coal	All coal weighed.
5. Average overall evaporation	9.12 lb. water per lb. coal	.....
Average for 10 hr. working day		
6. Average hourly evaporation	19,527 lb. per hr.	Calculated from item —1
7. Steam used through turbine ave.	16,500 lb. per hr.	From log readings.
8. Steam employed as high-pressure steam	3,027 lb. per hr.	Subtracting.
9. Total kw.-hr., 3 days	10,100 kw.-hr.	From switchboard meter.
10. Cost of all coal per kw.-hr. during 10 hr. day	$0.02	From items 4 and 9 coal at $6 per ton.

Table II shows among other things, that the turbine comes well within its guarantee, the performance of the generating machinery being for a typical week during February, 1925, under the supervision of H. P. Cheney, chief engineer of the plant. Operating costs are outlined in Table III as figured from three typical working days. The fuel cost of $0.02 per kw.-hr. includes the cost of heat furnished the process work during a 10-hour working day.

The investigation and installation work was carried out by Hatzel & Buehler, Inc., electrical engineers and contractors, New York. The seven-stage Terry turbine rated at 500 kw., 3,600 r.p.m., 175 lb. saturated steam, exhaust pressure 10 lb. gage, is connected to an Allis Chalmers 555-kva. alternator, 90 per cent P.F., 240 volts, three-phase, 60 cycles, amperes per terminal 1,340.

Three Pounds of Soda Ash Daily Saves Boiler Tubes in New Orleans Plant

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TUBE losses in boilers operated at high ratings, and particularly those in which fuel oil is burned, are becoming a question of much importance and in many stations a source of unlimited trouble. Tube losses involve considerable expense in replacement, but in those plants where boiler capacity is limited, boilers out of service are a matter of far greater consequence. Failure of tubes in oil-fired boilers in the Market Street station of the New Orleans Public Service, Inc., reached such alarming proportions during the months of July and August, 1924, that the immediate improvement of this condition became a matter of practical importance.

Before entering into the actual description of the methods used in decreasing tube failures, it will be well to give a general idea of the equipment so far as it might have an influence on the number of tubes lost.

ALTHOUGH it may seem incredible to those not entirely familiar with such problems, the author of this article, a competent chemist and boiler-plant man, reports that the addition of only three pounds of soda ash to a daily boiler feed of ten million pounds has checked serious tube losses in the oil-fired boilers at the Market Street Steam-Electric Generating Station of the New Orleans Public Service, Inc. This article analyzes the ups and downs of operation, relating the troubles encountered with burned-out tubes, the remedies and the results obtained.

The present plant contains fourteen 9,000-sq. ft. horizontal water-tube boilers, seven coal-fired with underfeed stokers, and located on the lower floor of a double-decked boiler room. On the upper floor are seven oil-fired boilers. As no great number of tube losses on the coal-fired boilers has been experienced recently, this article will deal primarily with conditions as found in the oil-fired furnaces.

There are at present seven mechanical atomization burners of the whirling-spray type under each oil-fired boiler. These were installed during the latter part of 1923 to give increased steaming capacity with the existing boiler equipment. Previous to this time two types of multi-plate burners were being used.

After the installation of the mechanical atomization burners, however, boiler-tube losses increased owing to the higher ratings and increased furnace temperatures. Practically all tube failures were confined to the lower rows, where apparently the impinging action of the flames produced overheating of the metal and burning out of tubes.

The type of failure was of particular interest and a general description will be given. All failures (See Fig. 1) had the general appearance of bags which, on examination, showed the presence of a hard brittle substance on the outside of the tube at the point of failure, which could be chipped off with a hammer, exposing the live metal. On sawing a tube in two at this point, it was seen that thinning of the tube wall took place on decomposition or oxidation of the metal from the outside. The brittle material, which could be chipped from the tube, looked much like coke or carbon, but on chemical analysis proved to be principally magnetite or magnetic oxide of iron, as is shown in Table I.

This oxide is produced under ideal conditions for its formation, which requires the action of superheated steam on hot or red-hot iron. In this case the metal apparently gets very hot when any unusual amount of scale forms inside the tube, producing a spot where the metal becomes overheated because of the poor heat conductivity of the deposit on the inside. The water resulting from the combustion of the available hydrogen in the fuel oil is evaporated and the steam produced superheated to the temperature of the furnace gases, thus supplying the necessary superheated steam for the oxidation of the iron. In every case of tube failure it was noted that there was a heavier deposit of scale at the point of rupture than at any other place in the tube.

This plant experienced heavy tube losses even at comparatively low boiler ratings on both coal- and oil-fired boilers some five or six years ago, when, during the winter months, it was impossible to treat successfully the makeup water in a cold-process chemical treating plant. At that time large quantities of makeup water were required and with its high hardness content, much heavy boiler scale formed, resulting in large boiler-tube losses. After reducing the total hardness of the makeup, as has been described in a previous article[1], tube losses decreased to a reasonable figure, and it is the trouble brought about by the recent increase in ratings on the oil-fired boilers with which the remainder of this article is directly concerned.

Boiler-feed water in this plant at present is composed of condensate returned from surface condensers of the generating units, makeup water produced by a double set of double-effect evaporators and condensation of exhaust steam in two open feed-water heaters. Previous to the installation of the evaporators in March, 1924, makeup was being produced by a modified hot-process chemical softener furnishing water containing approximately 1.3 grains per U. S. gallon of scale-forming materials and 1 to 2 grains of sodium carbonate and hydroxide. As surface-condenser leakage is closely controlled, the condensate from the turbine room is practically pure distilled water.

On increasing the ratings of the oil boilers, when using chemically treated makeup, boiler-tube losses increased correspondingly. It was believed, however, that

[1]October 17, 1922, issue *Power*: "Solving Feed-Water Problem at New Orleans."

as soon as evaporators were installed, this trouble would decrease to a negligible figure. The first month after the evaporators were put into operation, tube losses dropped to practically zero, as had been expected, and it was believed that this trouble had been solved for all time. Such, however, was not the case, as was soon found.

It might be explained that during the first two weeks of evaporator operation, water from a 900-ft. artesian well was used for distillation. This water is typical of the region and, besides much salt, contains sodium bicarbonate and organic matter in solution. After slight concentration in the evaporators, this water foamed badly, necessitating frequent blow-downs. All the distillate produced by evaporation of this water contained a considerable quantity of the soluble matter present in the original water.

In a short time the concentration of sodium chloride, sodium carbonate and sodium hydrate, resulting from the decomposition of some of the carbonate, produced foaming in the boilers themselves and even the condensate from the surface condensers showed distinct traces of sodium carbonate and hydrate. It took but a short time to be convinced that evaporation of this water was not at all practical, and from that time on the available city-water supply has been used with much success.

Analyses of samples of city and well waters are shown in Table II. With city water it is necessary to blow down the evaporator shells but twice daily, and the distillate produced has an exceptionally low total-solid content. At the present time evaporation for makeup runs about 5 per cent of the total boiler-feed requirement, which averages around 10,000,000 lb. a day.

It was but a relatively short time, however, after beginning the use of city water that tube losses began to increase rapidly again in spite of the excellent quality of the boiler feed being used. As a consequence, a series of investigations was immediately started to learn the exact reasons for this trouble and, if possible, to work out a method to prevent it. The first step taken was to make analyses of samples of all waters entering into the composition of the boiler feed, which were taken simultaneously. The results of these tests are shown in Table III. From these analyses it was concluded that a slight amount of hard water was getting into the boiler feed at some locality in the boiler room, as the hardness of the boiler feed showed up higher than would be expected from the analyses of the mixed condensates and the makeup. On investigation some few small leakages of raw city water into the feed-water system were found and remedied. Boiler-tube losses continued, however, in spite of the small scale-forming content, and it was determined to add enough sodium

Fig. 1—Tube failures of this type were common at the Market Street station until present methods were adopted

Left—Characteristic bag in tube. Upper right—Tube sawed at point of failure (top side). Note thinning of metal on outside by decomposition to magnetic iron oxide, some of which has been broken off to show the metal thickness. Lower right—Same as upper right.

carbonate to the boiler feed to precipitate all scale-forming materials in the form of calcium carbonate, which does not form a hard adherent scale as does the sulphate.

Using the results of the chemical analyses on the boiler feed, the necessary quantity of sodium carbonate to add per day was calculated. This figured out to be such a small quantity that it was at first decided to add a measured volume of artesian well water, carrying, as has been explained, natural sodium bicarbonate in solution, which breaks down into the carbonate when the water is boiled. Five hundred gallons of this water a day was used at first. This was admitted by gravity from a 200-gal. overhead tank through a 1-in. pipe line into the condensate line going to the feed-water heaters below. By barely cracking a valve, the well water was admitted slowly, requiring in all about two hours for admission of the quantity added daily. The water was added in two portions, one in the morning and the other in the late afternoon.

Tube Losses Practically Eliminated

This system for conditioning the boiler feed was first used Aug. 20, 1924, and the results were almost immediately apparent. Fig. 2 shows graphically the number of tube losses a month compared with the average boiler ratings during the same period. Beginning with

TABLE I—ANALYSIS OF A DEPOSIT FROM OUTSIDE OF A BOILER TUBE AT POINT OF TUBE FAILURE

From Boiler No. 13

	Per Cent
Insoluble and siliceous matter	2.00
Fe_3O_4 (Magnetic oxide of iron)	93.76
Undetermined	4.24
Total	100.00

the addition of well water, all boilers were given a slight blowing down every third day to reduce the quantity of sludge and precipitates formed. Results obtained by this method were entirely satisfactory so far as tube

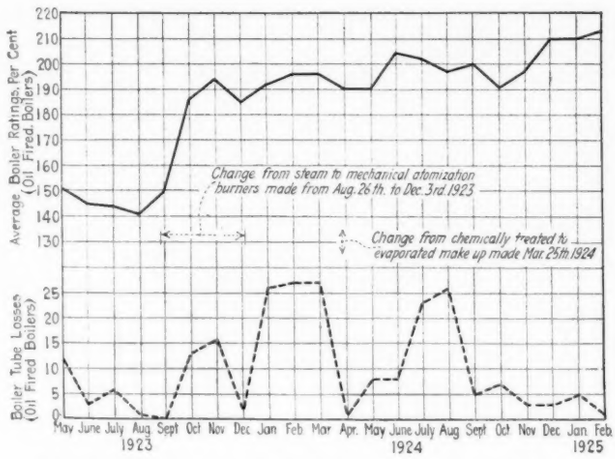

Average Boiler Ratings Per Cent (Oil Fired Boilers)
Change from steam to mechanical atomization burners made from Aug. 26th. to Dec. 3rd 1923
Change from chemically treated to evaporated make up made Mar. 25th 1924
Boiler Tube Losses (Oil Fired Boilers)
May June July Aug Sept Oct Nov Dec Jan Feb Mar Apr. May June July Aug Sept Oct Nov Dec Jan Feb
1923
1924
1925

Fig. 2—Effect of rating and operating methods on tube losses

During March, 1925, there were three tube losses, the average rating being 211 per cent.

losses were concerned, but on Oct. 26, a weak solution of commercial soda ash (sodium carbonate) was substituted for the well water, thus eliminating the addition of any unnecessary salts to the boiler feed.

At the present time three pounds of soda ash is used daily to treat the average evaporation of 10,000,000 lb. of water. The quantity of soda ash to use is now determined by weekly analyses of the boiler waters. Tests for total hardness, carbonate and sulphate contents are made. The relationship between the carbonate and sulphate content is the determining factor in the calculation of the quantity of soda ash to use. Recent research work done on the subject of boiler-water treatment has shown just what carbonate content is necessary in boiler waters with each content of sulphate to inhibit the formation of hard scale.

The question may arise as to why tube losses dropped off so suddenly when evaporators were first put into

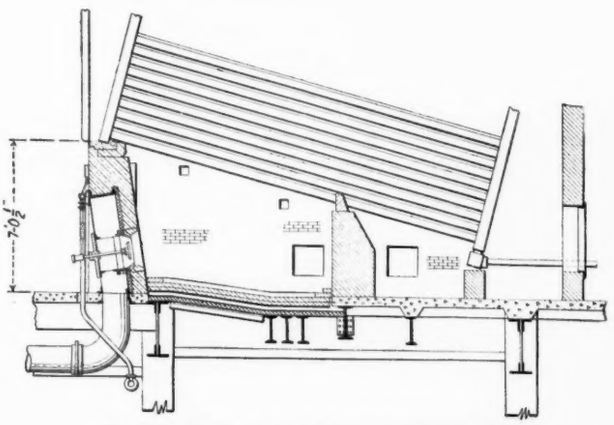


Fig. 3—Type of oil-fired furnace used

Combustion space 1,038 cu.ft.; 77,000 B.t.u. liberated per cubic foot per hour at 200 per cent rating.

service and then gradually increased again. As has been previously explained in this article, the makeup water produced by evaporation of the artesian well water carried with it, among other salts, a considerable

TABLE II—CHEMICAL ANALYSES OF WATERS

	Grains per U. S. Gallon— City Water	Artesian Well Water
Free carbon dioxide (as $CaCO_3$ equivalent)	0.00	0.00
Total alkalinity (as $CaCO_3$ equivalent)	1.54	25.16
Temporary hardness (as $CaCO_3$ equivalent)	1.54	4.39
Negative hardness (as $CaCO_3$ equivalent)	0.00	20.77
Permanent hardness (as $CaCO_3$ equivalent)	2.52	0.00
Total scale forming material (as $CaCO_3$ equivalent)	4.06	4.39
Alkalies as sodium sulphate (Na_2SO_4)	0.89	0.00
Alkalies as sodium chloride (NaCl)	1.73	52.94
Alkalies as sodium carbonate (Na_2CO_3)	0.00	22.02
Total foaming salts	2.62	74.96

quantity of sodium carbonate, which in the boilers increased greatly by evaporation. As soon as city water was used for distillation, no more sodium carbonate was at that time added to the boiler feed, and the sodium

TABLE III—ANALYSES OF WATERS*

(All results expressed in grains per U. S. gallon and represent total hardness as calcium carbonate ($CaCO_3$) equivalent)

Date sampled	8/12/24	8/18/24	8/20/24
No. 6 Turbine condensate	0.0361	.....	.....
No. 7 Turbine condensate	0.0000	.....	.....
No. 8 Turbine condensate	0.0288	.....	.....
Mixed condensates	0.0288	0.0144	0.0432
Evaporator makeup	0.0432	.....	.....
Boiler feed	0.0432	0.0575	0.0864

* Samples taken on the same date were taken simultaneously.

carbonate already in the boiler was being continually decreased by chemical reaction with those quantities of scale-forming material entering with the boiler feed, which came from small surface-condenser leakages etc. Eventually, all the sodium carbonate was used up, and after that time it is believed that hard sulphate scale, which seems readily to cause tube failures, was deposited. Tube losses increased at a rapid rate until

sodium carbonate was again added to the boiler water, which would indicate that the assumption just given is correct.

Thin Scale Caused Tube Failure

In Table IV will be noted an analysis of a sample of boiler scale taken July 26, 1924, which is typical of the character of the scale being deposited at that time. The high calcium-sulphate content will be noted. Although this deposit was not over $\frac{1}{4}$ in. thick, it was extremely

TABLE IV—BOILER-SCALE ANALYSIS

Date sampled	7/26/24
	Per Cent
$CaSO_4$—Calcium sulphate	55.22
$CaCO_3$—Calcium carbonate	33.38
SiO_2—Silica	2.75
Fe_2O_3 & Al_2O_3—Iron and aluminum oxides	1.15
MgO—Magnesia	.25
H_2O—Moisture	.09
Organic and volatile matter and undetermined	7.16
Total	100.00

hard and no doubt a very poor conductor of heat. A small thickness of this sort of scale caused tube failures; in the majority of cases it was under $\frac{1}{32}$ in. at the points of failure.

Up to the present time this method of treatment has given excellent results and the plant has been able to come successfully through those winter months when, due to high station loads and small boiler capacity, the loss of a boiler at certain times would have been almost disastrous to continuity of service. It is believed that this simple method of treatment might prove equally effective in other plants experiencing boiler-tube trouble when operating under somewhat similar conditions of boiler feed, boiler capacity, etc.

Undercutting or Slotting of Commutators

By Frank Huskinson

Slotting or cutting out the mica between commutator segments is believed by many to be a sure cure for all commutator troubles. As a matter of fact, slotting the commutator relieves certain troubles and is to be recommended for most machines. Several factors should be taken into consideration when the undercutting of mica is being considered. The most important of these are the conditions of operation, frequency of inspection and the peripheral speed. Slots that have been undercut are likely to fill up with dust, dirt and oil. This is especially true if the motor or generator is in a dusty or dirty place. If the machine is of the open type, care should be taken to see that there is no possibility of oil dripping on the commutator. Oil with carbon and copper dust will fill the slots with a conducting composition that will sooner or later cause short-circuits between the bars, flash-overs and the like.

A machine that has the commutator slotted should have frequent inspection, as there is a chance of small particles of copper, carbon and other foreign substances lodging between the bars. Such accumulations should be brushed out at frequent intervals.

A low-speed machine with an undercut commutator does not operate with the same degree of safety and satisfaction as a high-speed machine. The machine that operates at a sufficiently high peripheral speed to throw off by centrifugal force any particle of dust or other matter that may enter the slots requires less attention than the low-speed machine.

Some of the advantages of slotting the commutator are the increased life of commutator and brushes, elimination of flat spots and sparking and decreased heating of the commutator. The principal reason for slotting a commutator is to relieve it of high mica that has not worn down the same amount as the copper bars. The grade of material that is used in the insulation between the commutator segments is not always uniform. Some of the mica will wear down as fast as the copper bars, but it is a more frequent occurrence to have the copper bars wear down faster than the mica. The result is that the mica insulation between the segments is a trifle higher than the copper segments, and this results in a poor contact between the carbon brushes and the commutator bars. This is in turn intensified by the commutator rotating at a high speed.

High Mica Causes Chatter

High mica tends to cause the brushes to chatter, thus lessening the contact between them and the commutator. The result is that sparking takes place more or less violently, depending upon the condition of the commutator and the mica. Frequently, a case of this kind is aggravated instead of relieved by increasing the tension on the brushes, thus causing a still greater wear on the copper bars and brushes. This also causes increased heating of the commutator. There is only one remedy that will cure this trouble, and that is to undercut the mica. With a slotted commutator, brushes without any abrasive action should be used. The use of low-friction, non-abrasive brushes increases the life of both commutator and brushes, lowers the heating to a minimum and increases the efficiency of the machine, which permits an increase in the load on the machine.

A commutator that has a raw appearance and will not assume the glossy surface it should have, usually can be restored to satisfactory condition by undercutting the commutator. It will be found that the operation of almost any machine, be it motor or generator, will be improved by having the commutator slotted. If the commutator is eccentric or has flat spots, it should be turned or ground true before it is slotted.

Lubricants Should Not Be Used

Lubricants or compounds of any kind should not be used on a slotted commutator, as they will get in the slots and hold carbon dust and other dirt and may cause trouble. Where oil is likely to creep in on the commutator, it is advisable to paint the slots with shellac; this will prevent the mica from becoming oil soaked.

There are several ways and methods of slotting or undercutting a commutator. A number of devices are on the market. For the small plant and shops a short piece of a hacksaw blade held in a suitable holder is a convenient and rapid method; if the blade is too wide, grind off part or all of the set of the teeth. After cutting out the micas to a depth of $\frac{1}{32}$ in. or $\frac{1}{16}$ in., it is a good plan to take a file and bevel off the sharp edges of the copper bars slightly. A small groove turned in the commutator at the back or bottom of the risers is of decided advantage in the slotted commutator, as it leaves the slot open at the end and is very convenient during the process of slotting.

The brush pressure for a slotted commutator under average conditions is from 1 to $2\frac{1}{2}$ lb. per sq.in. of brush contact, for stationary motors and generators. Crane, elevator and street-railway motors will require a slightly heavier brush pressure.

R. H. Macy & Co. Claim $100,000 Yearly Power Saving

IN THE May 26 issue brief mention was made of an exhibit of unusual interest in a show window of R. H. Macy & Co. (department store), Thirty-fourth Street and Broadway, New York City. Intended primarily to advertise Macy's electrical show, this exhibit bore a message of interest to operating engineers in the form of a large inscription which read:

$100,000

was actually saved during 1924 because we operated our own plant—Another reason why Macy's prices on all merchandise are 6 per cent less.

According to Thomas Brennan, chief engineer, and John Cogan, assistant chief engineer, the actual saving was somewhat greater than this.

While the plant was described in the Dec. 4, 1923, issue of *Power*, and will be the subject of one or two additional articles in the near future, a few brief notes on its equipment and operation may help the reader to understand the reason for the savings reported. It is hoped that a cost analysis will be available later, thus affording opportunity to check and discuss the claims.

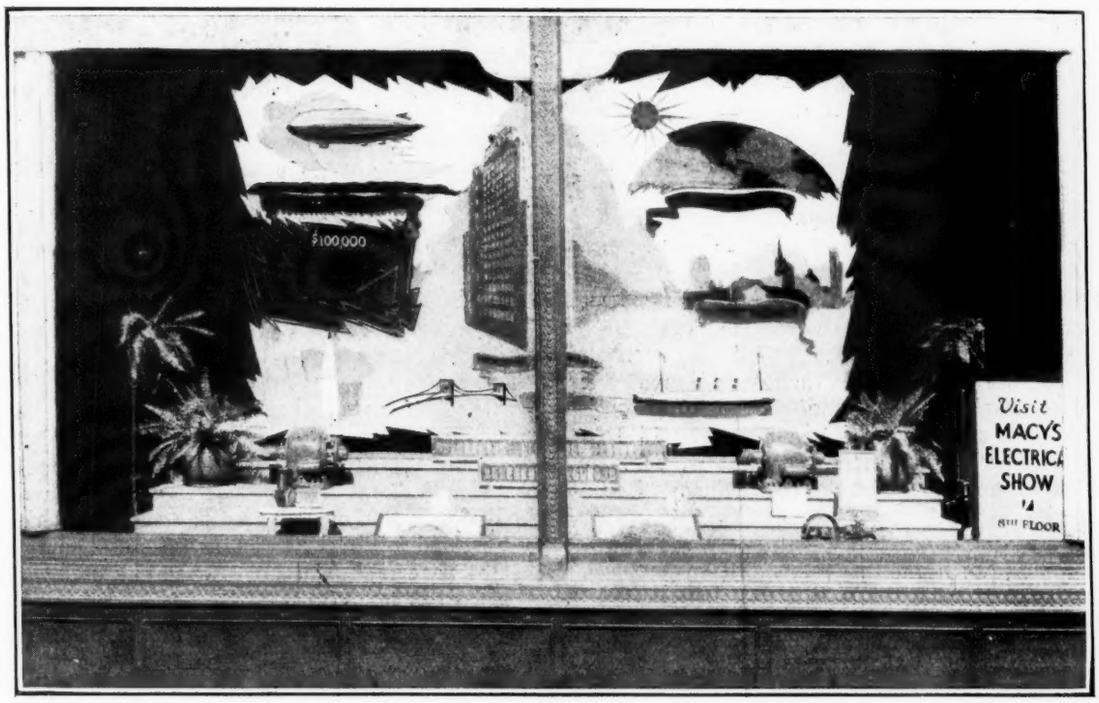
A nineteen-story addition to the store, bringing the total floor area to 1,550,000 sq.ft. was gradually opened for business during 1924.

The plant contains 27,500 sq.ft. of boiler-heating surface in 10 boilers, 9 of which are oil-fired. The coal-fired boiler is for emergency use only. Seven engine-driven 240-volt direct-current generators give a total generating capacity of 3,350 kw. In addition there is a 110-ton refrigerating plant and a variety of auxiliary equipment. Some conception of the size of this installation may be gained from the fact that the total fan capacity is 2,000,000 cu.ft. per min., and that 26 hydraulic and 26 electric elevators are operated, in addition to 25 escalators.

Most of the exhaust is utilized during the heating season, and much is used during the summer as well, for hot water, restaurant, etc.

The saving is said to include fuel, labor, supervision, repairs and $11,250 rent charged off for the space occupied by the power plant. It does not include interest and depreciation on the equipment. In this connection it should be remembered that the greater part of the equipment has long since been charged off.

Further information about the window display may be of interest to engineers in other large stores. The entire back part of the window was filled with a "set" painted in orange, deep blue and gold, with pictures and captions designed to give the average spectator some idea of the plant capacity and the work it could do.



Window exhibit ties in electrical show with graphic illustrations of the capacity of the power plant

A heavy express train was shown making ninety trips around the globe per year with the power produced. Other pictures showed the daily output raising the Woolworth building, Brooklyn bridge and the steamship "Leviathan" to various heights. Another showed the whole City of Albany lighted by this single plant. Beneath a drawing of the air ship "Shenandoah" was the statement that the air passing through the ventilating system would fill its 2,000,000 cu.ft. of gas bags in a single minute. In the foreground were models and photos of various power equipment used in the building, including a running model of a steam engine.

By logging the readings of the counter on a reciprocating feed pump daily and computing the fraction of a stroke or revolution per kilowatt-hour or the number of revolutions per 1,000 lb. of steam evaporated, a ready check can be kept on the condition of the pump, it being at once apparent when the slippage has become sufficient to warrant overhauling.

Pipe Welding at Westport Station

SINCE 1912 welding has been utilized for making pipe joints at the Westport station of the Consolidated Gas, Electric Light & Power Company, at Baltimore. About 4,000 such joints (line welds) have been installed, including 2,700 made on steel pipe. The recent addition to the station contains bolted-flange joints only where necessary for installing orifices, attaching valves and the requirements of erection, inspection, etc. As a result of the methods employed, practically no trouble has been experienced to date, while on the other hand the permanent tightness and other factors incident to welding have proved in some ways definitely advantageous.

The time required for making a welded joint is one of the most important considerations. Where piping must be changed, sections can be cut and welded in place much more quickly than by the use of screwed fittings. Final alignment sometimes can be secured by adjustments at the joints before welding. Complicated shapes made up by welding pieces of standard bends, ordinarily are cheaper and quicker to construct than by the usual methods of fabrication. Sections and bends of piping left over from a former installation are thus easily utilized, whereas new material would otherwise be required.

The cost of a reinforced welded joint for normal station pressure is around one-fourth that of a heavy Van Stone joint, including erection. It has been the experience at this station that when a section of pipe is removed and replaced, the cost of welded joints is less than that of new gaskets, bolts and labor required for bolted connections. The cost of the joint is, however, less important than savings due to convenience of erection, alignment, etc.

Two kinds of joints are utilized. For low-pressure work and sometimes higher pressures, the usual butt-weld is employed wherein the ends of the pipe are each beveled at 45 deg., thus allowing an included angle of 90 deg. to be filled with the welding metal. For higher pressures a joint of this kind is reinforced by fastening strips lengthwise across it. Thus, for an 18-in. pipe the welding metal would be kept slightly below the outside pipe diameter, and six steel strips of ⅜x3-in. section welded at equal intervals across the joint, lengthwise with the pipe. These strips are first welded at one end and then heated, finally being welded at the other end. On cooling the strips are in tension.

Reliability is secured by testing the joints and checking up the work of the welders. Welds are tested under hydrostatic pressure at twice the normal operating pressure when in the field and at three times the operating pressure when made up in the shop. While under this pressure they are beaten with hammers ranging from 2 lb. to 12 lb., depending on the size of the piping. The latter would be required for a 20-in. header.

If a weld sweats moisture, it is not repaired, but on the contrary the entire welded joint is cut out and made again. Reinforced joints are thus tested before the reinforcing strips are applied. A certain percentage of welds made in the shop by each welder is cut up and given a tensile test as well as examined for porosity. With proper handling of the welders, together with the required service test, it is believed that a reliability equal or exceeding that of bolted flanges is obtained.

About one-quarter of the pipe-joint welding is done electrically, being confined to low pressures and temperatures, where stresses are light. The efficiency of an electric-welded joint based on tensile strength is seldom over 50 per cent as compared with the unwelded pipe. Gas welds show an efficiency in excess of 90, about three-quarters of such joints tested having broken outside the weld, representing an efficiency in excess of 100 per cent. Miscellaneous repair work is carried on to great advantage by the electric process, in some instances savings of about 90 per cent being realized over the cost of new repair parts.

Gas-welded pipe joints are made with low-carbon welding rods. Joints are tacked together at intervals with welds and then secured by welding from these fastenings. They are then normalized by heating to about 1,400 deg. F., with air cooling. In the case of reinforced joints the hydrostatic hammering test is next made, and finally the reinforcing strips added.

Corrosion has shown no increased activity in the region of welds after twelve years' service. Microscopic investigation indicated no difference of attack on weld or pipe metal. Where pinholes appeared, none was found within two inches of a weld.

On entering the new addition of Westport station the piping attracts attention on account of the scarcity of bolted flange joints. About 90 per cent of bolted flanges as usually employed, are here eliminated. Bends of many kinds are in view without any indication of bolting on a standard ell. A steam header for 200 lb., 700 deg. F., total temperature in one instance extends about 200 ft. without a bolted flange unless accompanied by a welded joint. Much of the piping is made up from that of a former installation. In the boiler room for instance are many crosses for 20-in. pipe. These are constructed by welding 24-in. pieces together, 20-in. pipe flanges for bolts being added to each outlet, also by welding. In order to make these joints, the larger pipe is reduced in diameter to match the welding flange by a process resembling the reverse of "Van Stoning." In addition, 6-in. drains are sometimes added at the bottom of the cross.

Each steam connection from the turbine throttle valve to the main header that can be seen in Figs. 1 and 2, is made up of standard bends cut in suitable sections and welded with reinforced joints. The pipe in Fig. 1 makes a sharp bend to the left after passing through the wall. The difficulty of designing and fabricating bends of this character can be appreciated as compared with the convenience of utilizing odd lengths of material which is aligned before making the last weld.

The "stovepipe joint," Fig. 3, can be seen to make unnecessary the use of a standard fitting where the horizontal and vertical pipes meet just above the floor. A tee would also ordinarily be required where the upper bend leaves the horizontal run, being instead here attached with a weld. Difficult shapes can be easily made up from pieces of standard bends and nipples. The insert at the left shows two large horizontal pipes and a vertical joined together, a smaller line being welded in near-by.

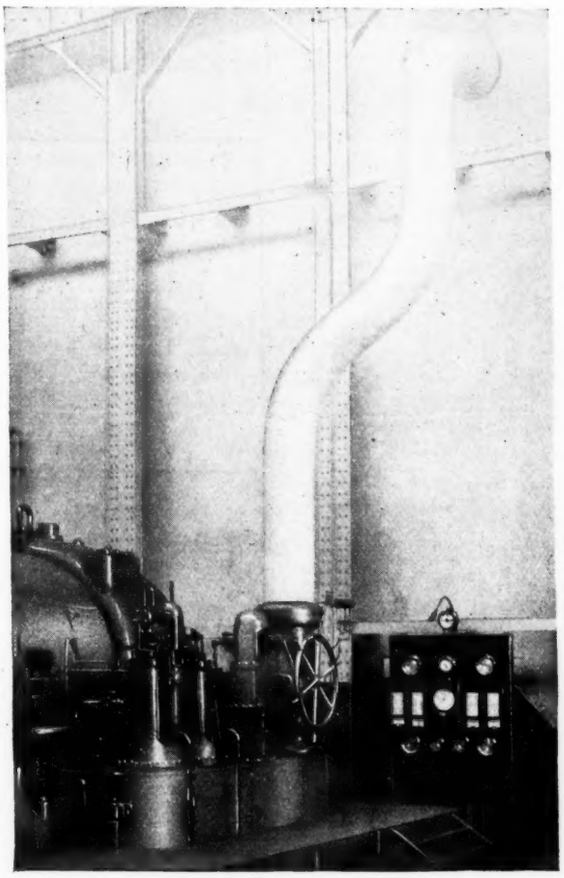


Fig. 1—Connection from throttle to header as shown contains three reinforced welds

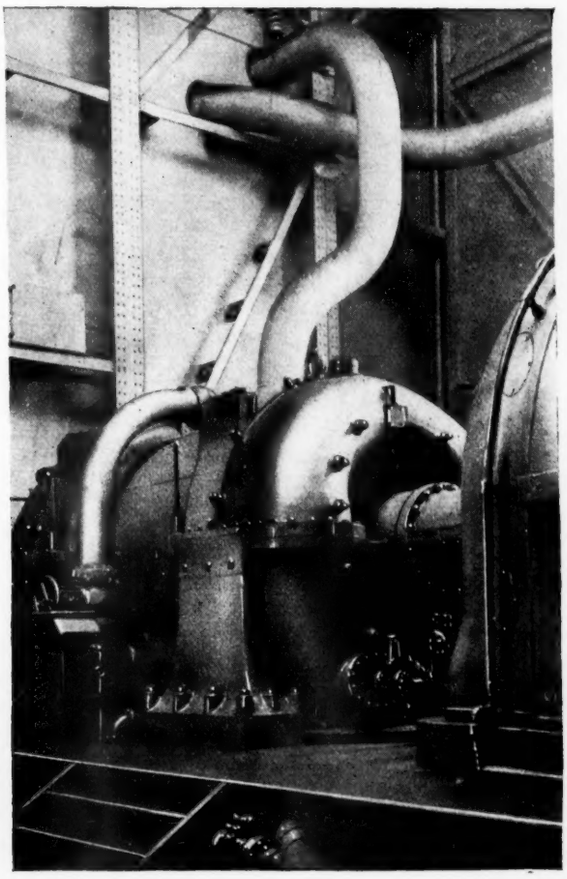


Fig. 2—Fabricated steam pipe would cost much more than the welded shape here shown

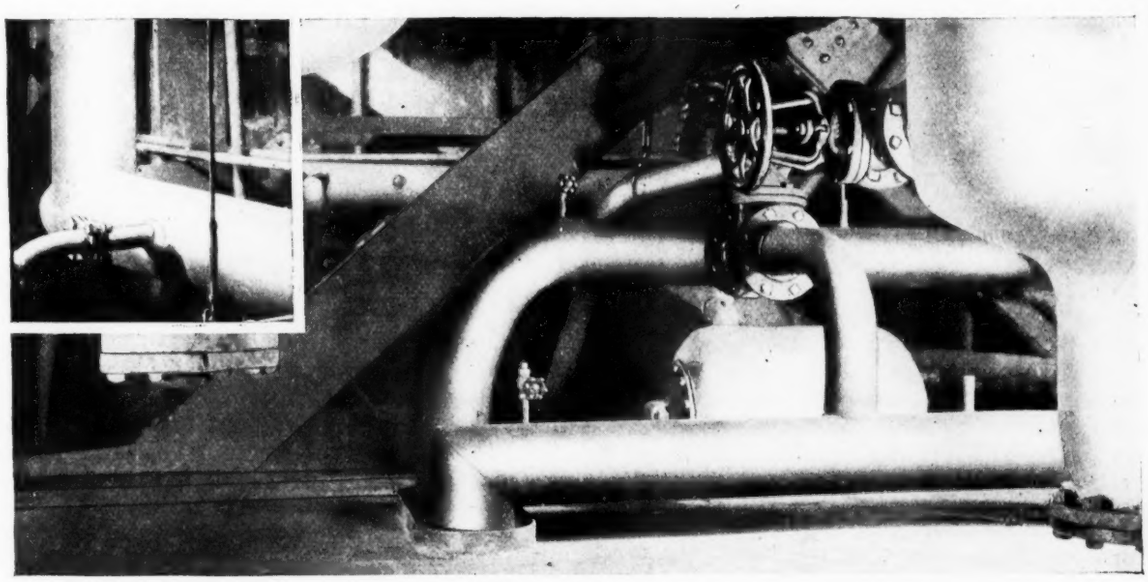
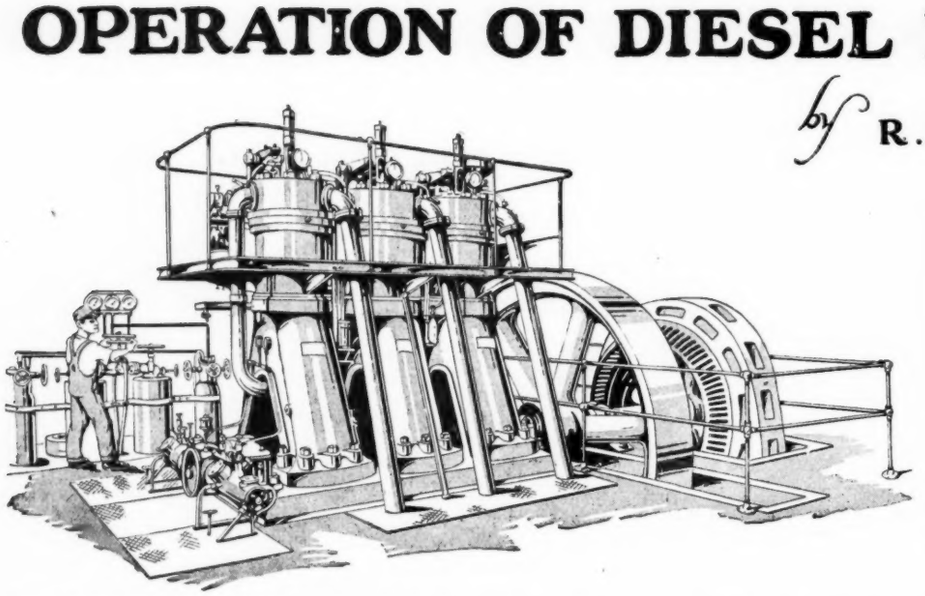


Fig. 3—The "stovepipe" type of joint is found convenient for low pressures. Complicated piping may be fitted and welded on the job, making detailed layout unnecessary

OPERATION OF DIESEL ENGINES

by R. Hildebrand *



Why Cylinder Heads Break and The Remedy

BOTH the external forces and the heat of combustion cause stresses in the cylinder head, particularly in that part of the bottom directly exposed to the heat. Stresses due to heat are the ones that endanger the head most. Even in a well-designed and carefully manufactured cylinder head these stresses are high, and it is necessary that the operating engineer take proper care of the head, otherwise it will fail.

Referring to Fig. 1, which shows a bottom view of the cylinder head most commonly used, it is obvious that the stresses along the line *AB* are the greatest, as this section is prevented from expanding freely.

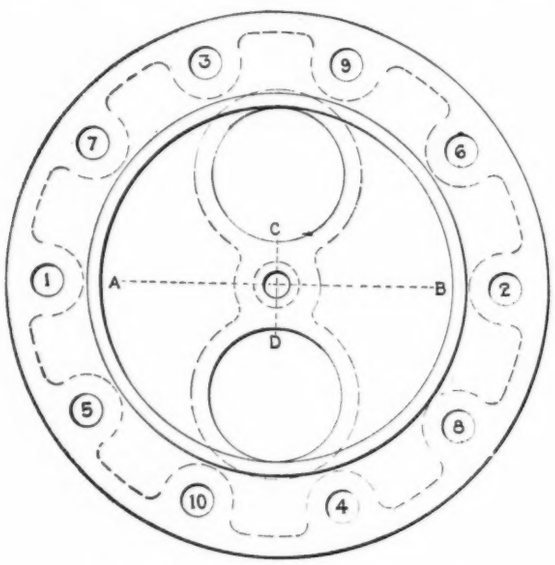


Fig. 1—Stresses in cylinder heads

The stresses in the fibers along *CD* are the smallest, as these fibers are short and can freely expand by deforming the large valve-port openings. It is not surprising that the head, if it should fail, would crack along the line *CD*, being at right angles with *AB*, because the fracture is always at right angles with the stress.

To permit the fiber *AB* to expand freely when the engine heats up, as after starting, and to contract freely when the engine cools down, I designed the cylinder head shown in Fig. 2. It will be noticed that here the water jacket has substantially an oval shape and the bottom plate at *A* and *B* is cut away to permit

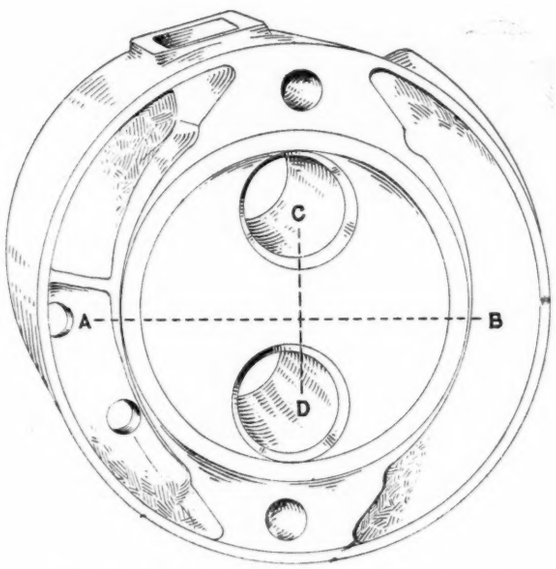


Fig. 2—Head designed to relieve stresses

the fibers *AB* to expand and to contract freely. In the usual head the part of the bottom plate outside of the gasket, not exposed to heat but water cooled, acts as an unyielding margin or as a shrink collar around the fibers *AB*, preventing their expansion. The cylinder head shown in Fig. 2, built according to my patent, has given excellent results.

There is still another group of heat stresses. These are caused by the uneven temperature of the bottom plate, which is heated by the burning gases on one side and cooled by water on the other. This uneven temperature tends to expand the heat-exposed side more than the side in contact with the cooling water. This results in stresses of the material.

The pressure of the gases below the cylinder head tends to deflect the head upward, as shown in Fig. 3,

*Chief Engineer, Diesel Division, Fulton Iron Works Co.

causing tensile stresses in the bottom plate. It is obvious that the forces exerted by the bolts holding the head to its seat should not materially exceed the pressure of the gases. Any additional forces exerted by these bolts will cause an additional upward deflection of the cylinder head and consequently additional stresses. That this is the case will be understood if it is considered that the bolt forces act outside of the gasket as shown in Fig. 4.

Having analyzed the causes and nature of stresses in the bottom plate of the cylinder head, the question arises as to how to take the best care of the head, holding its stresses to a minimum, and thus lengthen its life.

It is most important to prevent scale and mud from accumulating, as they interfere with the effective cooling of the bottom plate. Long life should not be expected if the head is not properly cooled.

Overstressing Bolts Is Dangerous

The writer most urgently advises the engineer not to tighten the nuts of the bolts holding the cylinder head to its seat more than necessary, as this will increase the stresses in the head and will endanger the cylinder and liner. Tighten these nuts according to a definite plan, as shown in Fig. 1, where the numbers given indicate the sequence that should be followed in drawing down the nuts. Then go over all the nuts

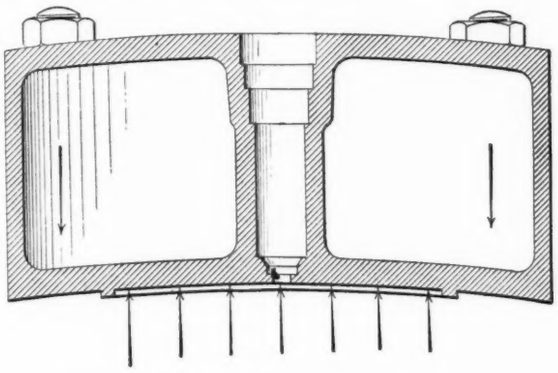


Fig. 3—Action of gas pressure on head

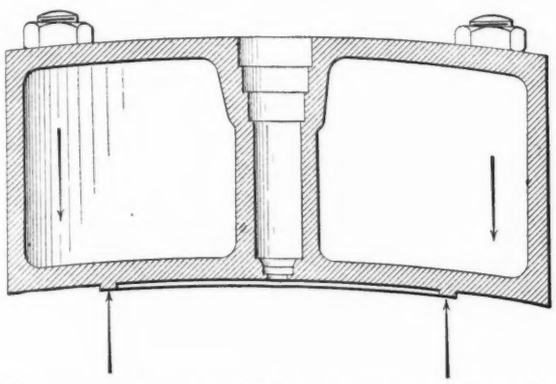


Fig. 4—Drawing up of bolts increases bending effect

once more, drawing them tighter, and follow up a third time, until all are drawn sufficiently and equally tight. If the work is done when the engine is cold, it is advisable not to tighten the nuts as much as when it is hot, but rather do the final tightening after the engine heats up.

The surfaces of the seat should be ground if the gasket between the head and cylinder liner does not hold tight unless the nuts are heavily sledged. Since the seat of the head cannot be ground to the seat of the liner on account of the studs, it is necessary to use a grinding ring *A*, shown in Fig. 5. This ring may also be used for installing the piston by providing a means for compressing the rings.

The seats for the various valve cages should also be ground occasionally, otherwise they will not hold tight. These seats or the valve ports may break if,

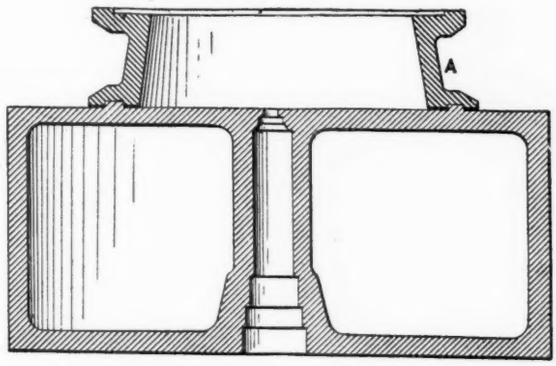


Fig. 5—Ring used to grind head seat

instead of grinding the valve seats, the nuts holding the valves in place are tightened unreasonably, to stop leakage.

How To Read a Hydrometer

The correct method of reading a hydrometer is illustrated with the directions in Circular No. 57 of the United States Bureau of Standards. The sample of oil is placed in a clear glass jar or cylinder, and the hydrometer is carefully immersed in it to a point slightly below that to which it naturally sinks and is then allowed to float freely.

The reading should not be taken until the oil and the hydrometer are free from air bubbles and are at rest. In taking the reading the eye should be placed slightly below the plane of the surface of the oil and then raised slowly until this surface, seen as an ellipse, becomes a straight line. The point at which this line cuts the hydrometer scale should be taken as the reading of the instrument.

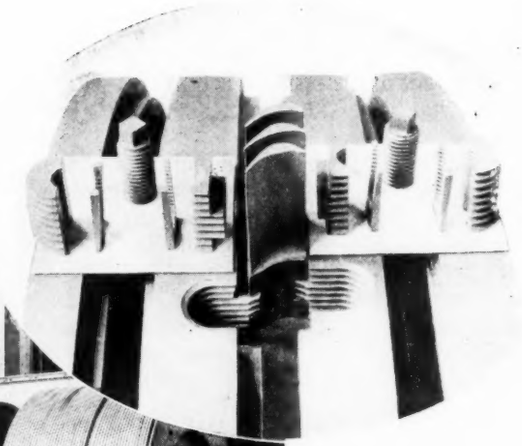
If the liquid is not sufficiently clear to allow the reading to be made as described, it will be necessary to read from above the surface and to estimate as accurately as possible the point to which the liquid rises on the hydrometer stem. It should be remembered that the instrument is calibrated to give correct indications when read at the principal surface of the liquid. It will be necessary, therefore, to correct the reading at the upper meniscus by an amount equal to the height to which the oil creeps up on the stem of the hydrometer. The amount of this correction may be determined with sufficient accuracy for most purposes by taking a few readings on the upper and the lower meniscus in a clear liquid and noting the differences.

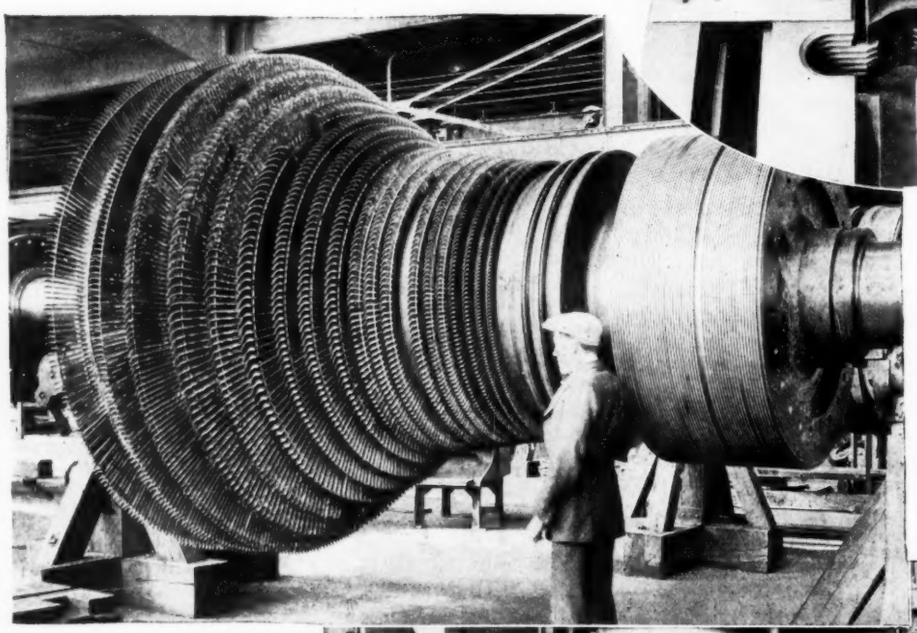
A specific-gravity hydrometer will read too low and a Baumé hydrometer too high when read at the upper edge of the meniscus. The correction for meniscus height should therefore be added to a specific-gravity reading and subtracted from a Baumé reading.

Some Structural Details of a Reaction Turbine

Right—Locking the last blades in place

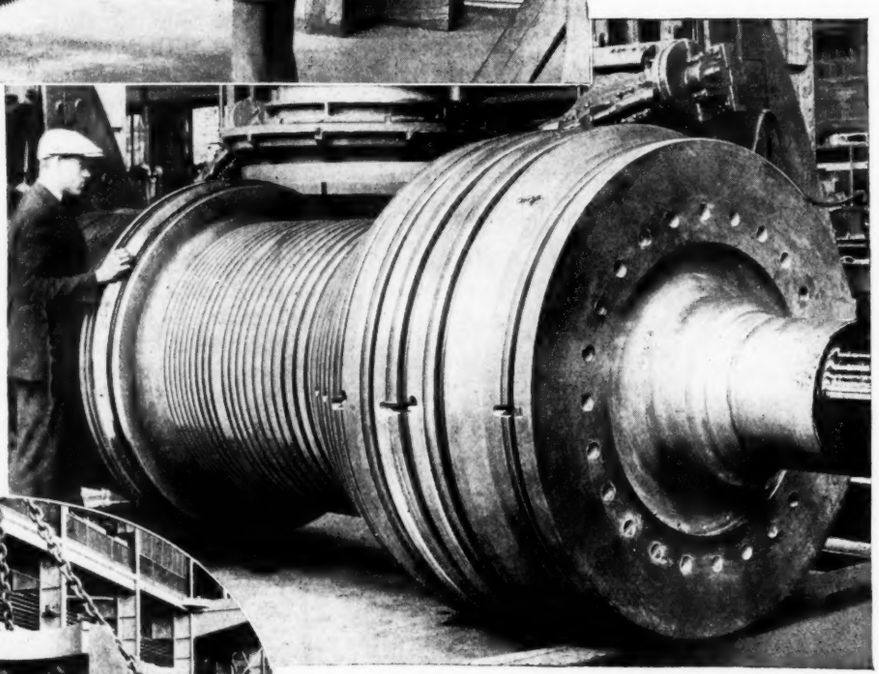
The small pieces of irregular shape, when properly inserted in the side slots, lock the roots of the last blades. Considering the left side of the blade row, the adjacent lock piece is held against it by the pressure of the U-shaped wedge between the half sleeve at the left and the U-spacer on right. To hold all secure, the square-headed plug is screwed in, cut off flush with spindle body and locked in the threads with a center punch.

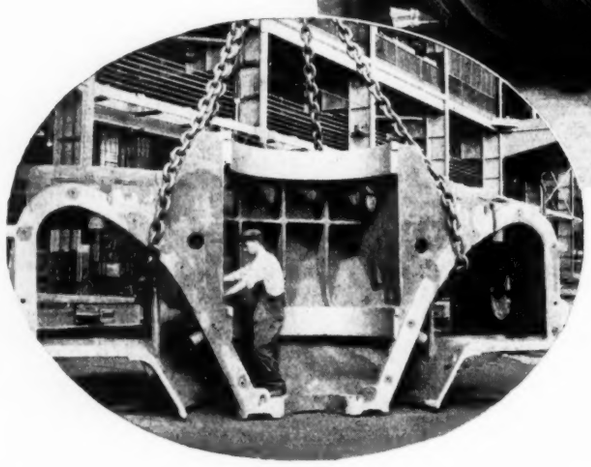




Left — Rotor with blading in place. Note dummy pistons on the right and rows of special multi-exhaust blading at the left

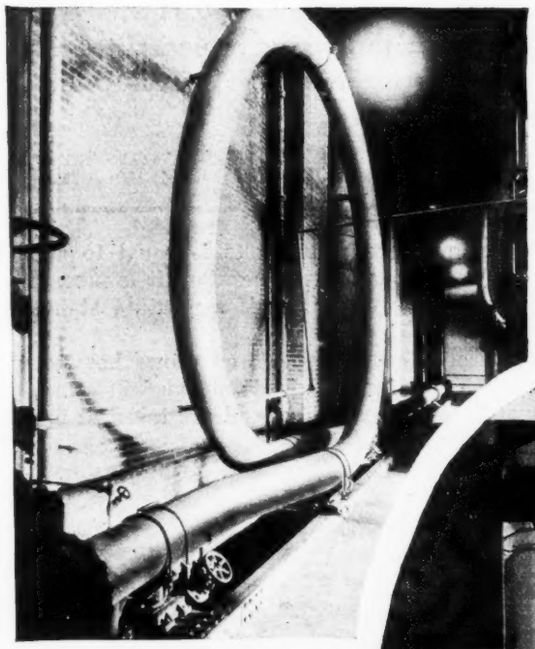
Right—How the rigid-type rotor looks before blades are attached. Note special side slots (already explained) for use in locking the last blades of each row





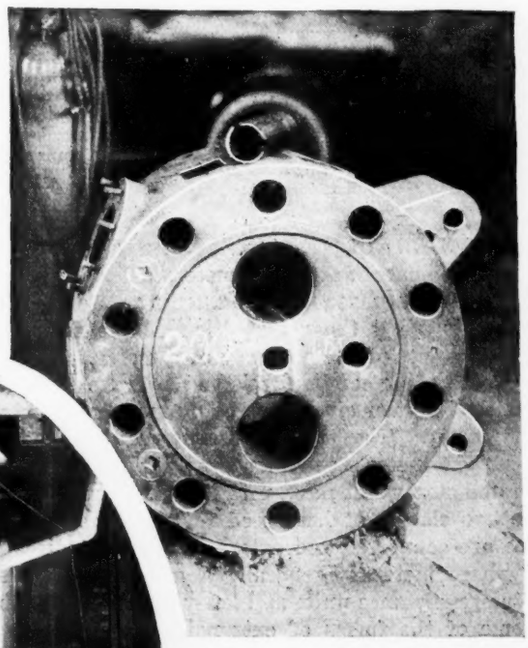
Left—Exhaust end. Note stream-line partition next to chain on left

Photos taken especially for Power at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co.



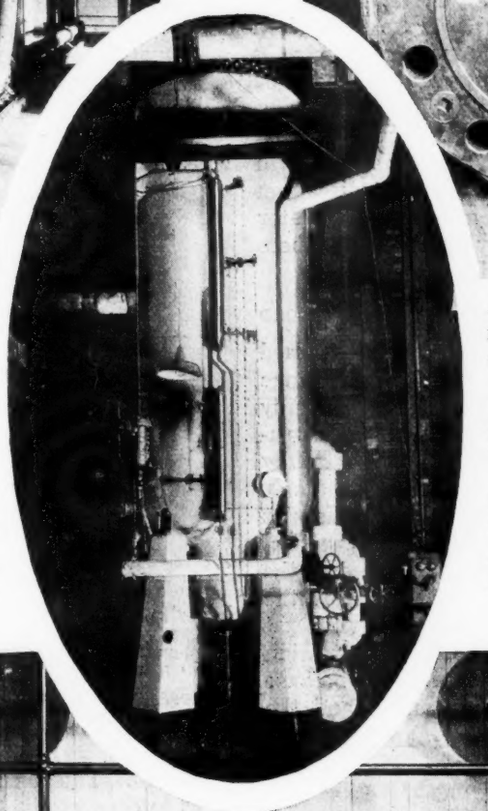
Above—Expansion coil in the new Peoria station of the Illinois Electric Power Company

Photo from Midwest Piping & Supply Co.



Above—Cracked Diesel head repaired by oxyacetylene welding as indicated by chalk marks

All four heads were cracked. One new head was purchased so the engine could be kept in operation while the heads were welded one at a time.

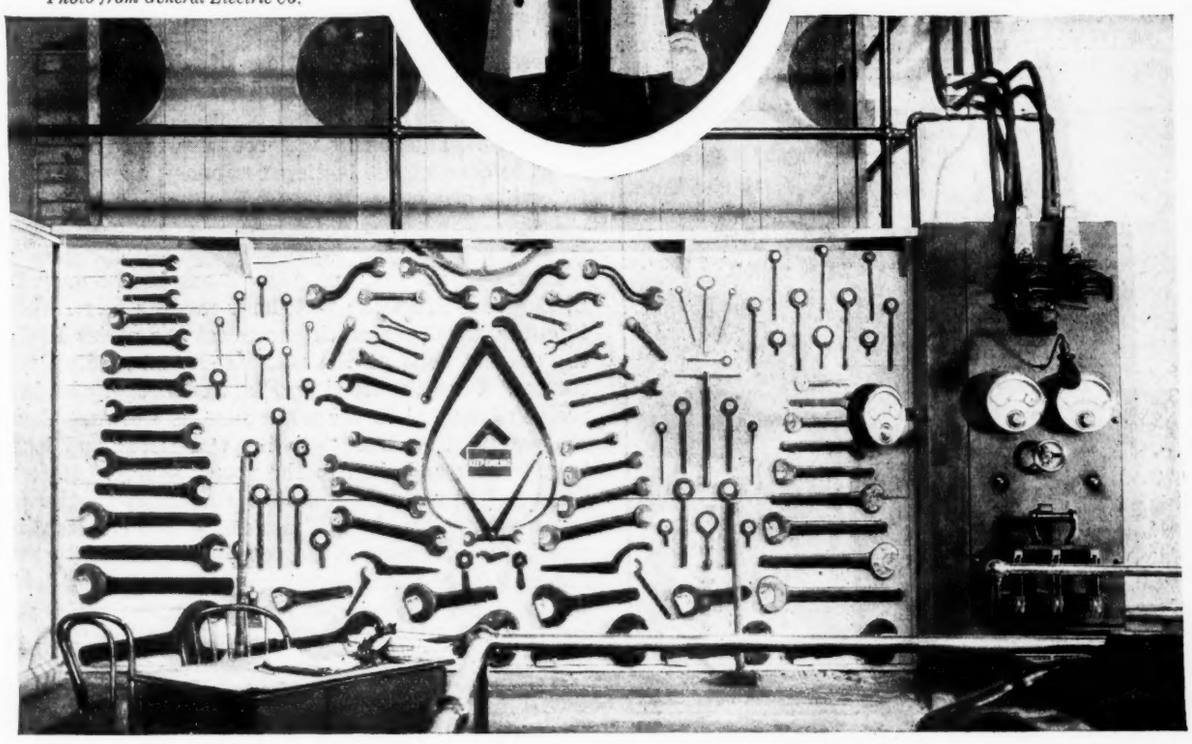


Right — Five-thousand kilowatt electric boiler at St. Croix Paper Co., Woodland, Me.

Operating at 6,600 volts and 150 lb. steam pressure, this boiler is used to smooth out the hydro-electric-power consumption curve of the mill and particularly to heat the mill on Sundays and holidays.

Photo from General Electric Co.

Below — "A place for everything and everything in its place." Toolboard in the Doubleday-Page power plant, Garden City, L. I.



Testing Polyphase Watt-Hour Meters

By WILLARD F. WALSH
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TESTING polyphase watt-hour meters having two current and two potential coils for use on three-wire, two- or three-phase and four-wire two-phase circuits. Consideration is given to the method of testing with a single-phase wattmeter.

CONSIDERABLE care must be exercised in testing a polyphase watt-hour meter, as it consists of two single-phase meter elements whose individual adjustments affect the registration of the meter as a whole. The test of the accuracy of a meter is made for the purpose of determining if the power being used on a definite circuit or circuits is being measured correctly by the meter. The two most convenient methods of checking the meter's accuracy are: Indicating instruments and stop watch; and rotating standard.

The two classes of load used for testing a meter in service are connected and external. Connected load on a polyphase meter is generally a motor load. Water rheostats, resistance units and low-voltage transformers are some of the forms of external loads used.

Rotating Standard Preferred With Connected Load

When connected load is used, the rotating standard is preferable and more accurate because every change in the line voltage or the amount of load is readily accounted for by the standard, whereas when instruments are used it is necessary to watch very carefully the variations and to average the wattmeter readings. Although it is possible to insert a form of rheostat to attempt to hold the load constant, it is not practical because a motor load is always fluctuating, and the rheostat would undoubtedly be quite large owing to the size of the wire necessary to carry the load.

Ammeters and voltmeters are of no value in testing an alternating-current meter with a motor load because the power factor is always less than unity, and the product of amperes times volts is equal to apparent watts and not actual watts, therefore it is necessary to use an indicating wattmeter if a rotating standard is not available.

The method that is considered shows how to make the test using an external load with an indicating wattmeter and stop watch. The readings taken at first will be with the current coils in series and the potential coils in multiple. The rating of the meter to be tested is 50 amperes 220 volts three-wire three-phase 60-cycle General Electric Type D-6, one of which with the cover removed is shown in Fig. 1. Fig. 2 is a diagram of the meter, switches, fuses, etc., before the connections are disturbed. The circuit is three-wire three-phase. The steps to connect the testing equipment are made in the following order, as shown in Fig. 3:

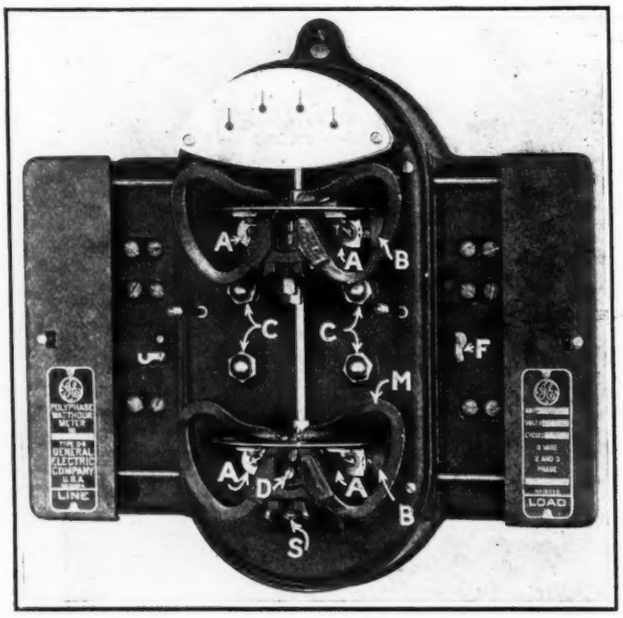


Fig. 1—Polyphase watt-hour meter with cover removed

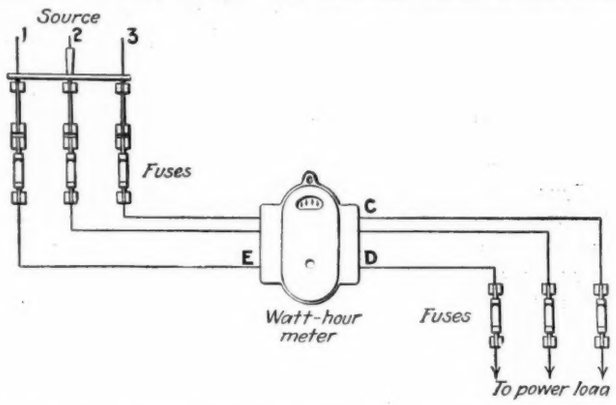


Fig. 2—Connections for polyphase watt-hour meter, Fig. 1, connected to three-wire three-phase circuit

Making Connections for Testing

First connect jumpers *A* and *B* and then remove leads *C*, *D* and *E* from the watt-hour meter's terminals and tape the ends. After this, connect the series lead and the current coils of the wattmeter and loading transformer. Open the test loop *F* and connect the lead from the top terminal to the main fuse as shown. Connect the potential leads first to the wattmeter and loading transformer and then to the power source. Note that these potential leads must be connected to the same phase as that supplying the meter. If the meters indicate backward, reverse the potential leads at the fuses. The watt-hour meter should be checked at the following loads: Light loads 10 per cent of ampere rating; normal load, 50 to 60 per cent of ampere rating; full load, 80 to 100 per cent of ampere rating.

It may be necessary to change the size of the wattmeter unless it has various ranges, as a low reading on the scale is not very accurate. The cover of the

meter should not be removed before taking the initial readings. Stop-watch readings of the meter's disk speed are taken, the time of the reading being from 40 to 60 sec. Start and stop the watch as the black mark on the disk passes an edge of the retarding magnet. The same edge of the magnet and also the same end of the black mark must be used in starting and stopping the disk to avoid error in the result. particularly when taking only a few revolutions. The meter accuracy is determined from the formula,

$$Accuracy = \frac{Meter\ watts}{True\ watts}$$

Meter watts are calculated from the formula,

$$Meter\ watts = \frac{3{,}600 \times R \times K}{S}$$

where

3,600 = Number of seconds in an hour;
R = Number of revolutions made by meter's disk;
K = Constant marked on meter's disk by manufacturer, equals number of watt-hours per revolution of disk;
S = Number of seconds shown by stop-watch to make the number of revolutions R of meter's disk.

True watts are read from the indicating wattmeter. If there is a correction for the reading, it should be applied before the meter watts are calculated. When using an external load, there will probably be but little variation in the reading unless the voltage fluctuates

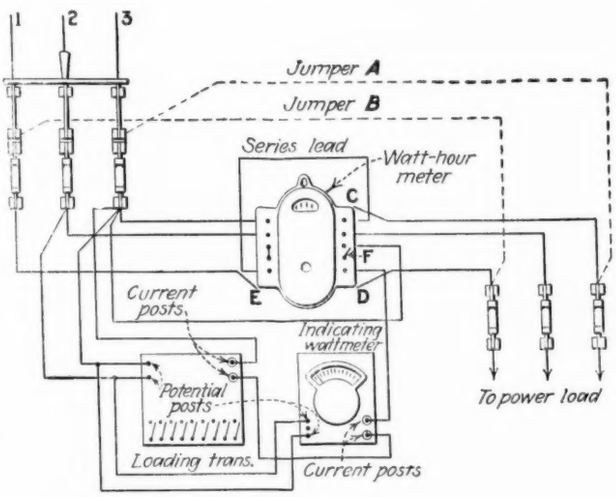


Fig. 3—Connections for testing watt-hour meter, Fig. 1, with watt-meter and loading transformer

considerably. However, it is best to watch the indications carefully in order to obtain the average reading.

The constant marked on the disk of this meter is 12. However, since the current coils of the meter are connected in series, this constant is halved and therefore is equal to 6. The first load put on the meter will be light load. Suppose the disk makes 3 revolutions in 58.4 sec. and the indicated watts are 1,100 with no correction for this reading; then

$$Meter\ watts = \frac{3{,}600 \times 3 \times 6}{58.4} = 1{,}109$$

$$Accuracy = \frac{1{,}109}{1{,}100} = 1.008$$

Therefore the percentage accuracy is $1.008 \times 100 =$ 100.8, or the meter is 0.8 per cent fast. Now assume approximately 50 per cent load is placed on the meter with the following results:

The disk makes 15 revolutions in 59.1 sec. and the average indicated watts are 5,405. In this case the indicating wattmeter reads 5 watts high, as has been

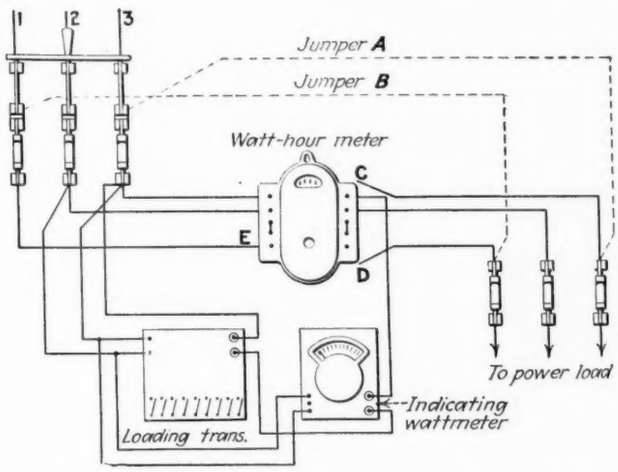


Fig. 4—Connections for testing upper element in watt-hour meter, Fig. 1

determined by a previous calibration, so the corrected watts equal 5,405 — 5 = 5,400.

$$Meter\ watts = \frac{3{,}600 \times 15 \times 6}{59.1} = 5{,}482$$

$$Accuracy = \frac{5{,}482}{5{,}400} = 1.015$$

Therefore, the meter is 1.5 per cent fast on 50 per cent load. Now place full load on the meter and take a reading of 30 revolutions of the meter's disk. Suppose that the meter is found to be 1.5 per cent fast on full load.

Evidently, this meter is fast by more than one per cent and should be adjusted. However, a check should first be made on the separate elements to determine if they balance within about one per cent. This check is made on approximately 50 per cent load at unity power factor. The connections for the upper element are to be made as in Fig. 4. The test constant K is now 12 because only the upper element is being tested.

Consider that the reading of the stop watch at a load of about 25 amperes is 39.5 sec. for 5 revolutions with a reading of 5,405 watts, 5,400 watts corrected.

$$Meter\ watts = \frac{3{,}600 \times 5 \times 12}{39.5} = 5{,}468$$

$$Meter\ accuracy = \frac{5{,}468}{5{,}400} = 1.012$$

or the upper element is 1.2 per cent fast.

Fig. 5 shows the connections for checking the lower element. Note that the potential leads are changed to the other phase and also that the current circuit is changed from line 3 to line 1. Suppose the check on this element shows it to be 3 per cent fast. Comparing the accuracies of the elements, we find that the lower is 1.8 per cent faster than the upper. This difference should be decreased to within one per cent. The cover of the meter should now be removed. Four brass caps C, Fig. 1, are located between the magnets, and under these caps are hexagonal bushings, two for each element. To adjust, turn the two bushings of either

element in the same direction. Turning the bushings clockwise decreases the torque of that element, and counterclockwise increases the torque.

To adjust the meter that is being tested, turn the bushings of the lower element clockwise until the meter runs about one per cent fast. Then connect the upper element as in Fig. 4 and recheck it. If the elements are now within one per cent of each other in accuracy, the meter should be connected as in Fig. 3 and adjusted as follows:

Change the position of the lower magnet *M* a little by loosening the clamping screws and turning the calibrating screw *D* clockwise. This will move the magnet out and will slow the meter down. An adjustment of this magnet to approximately 100 per cent accuracy on full load will bring the meter within a close accuracy on all loads. Light and normal loads should again be checked.

Moving the magnet in speeds the meter up. The upper magnet should not be touched unless the meter is considerably fast. Its effect on the meter is the same as the lower magnet. Therefore moving either magnet affects the meter as a whole, and not independently on each element. The light-load adjustment, however, does affect its element independently. This adjustment consists of shifting a plate located directly under each disk, by turning a micrometer adjusting screw. To adjust, loosen the clamping screws *A* and turn the adjusting screw, located at *B*, toward *F* on the screw support, to speed up the meter and toward *S* to slow it down. When adjustments for light loads have to be made each element should be done separately and then connected in series for the final check.

If the meter tested above had been found 100 per cent or under on light load and 1.5 per cent fast on

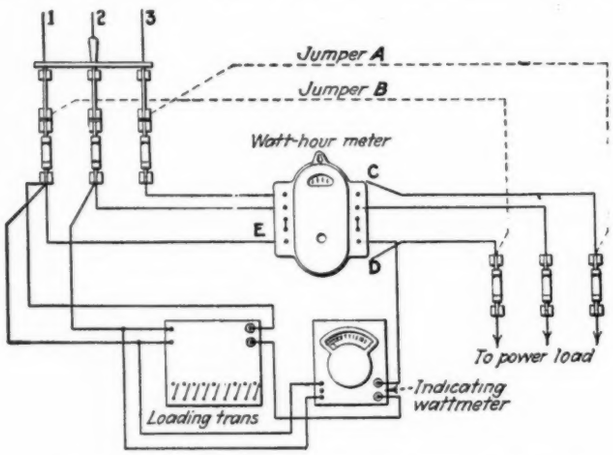


Fig. 5—Connections for testing lower element of watt-hour meter, Fig. 1

normal and full loads, it would have been necessary to speed up on light load after slowing down on full load. A shifting back and forth between adjustments will be necessary until the meter is left within commercial limits, which is generally within one per cent fast or slow.

Later types of meters have easily accessible adjustments for balance of elements and also for light and full-load adjustments. The meters are adjusted at the factory for inductive load, which very rarely changes, and it is recommended that one should not attempt to change this adjustment unless familiar with meters and methods of obtaining various power factor loads. Some of the causes of incorrect meters are as follows:

Weak magnets will cause a meter to be fast on full load and light load. Loose magnets may cause it to be either fast or slow on full load.

Broken jewel, dirty bearings, bent top bearing and dirt on disk will produce friction, which will cause the

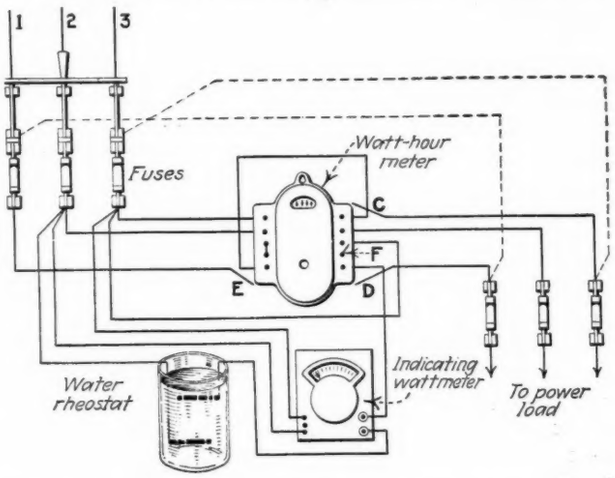
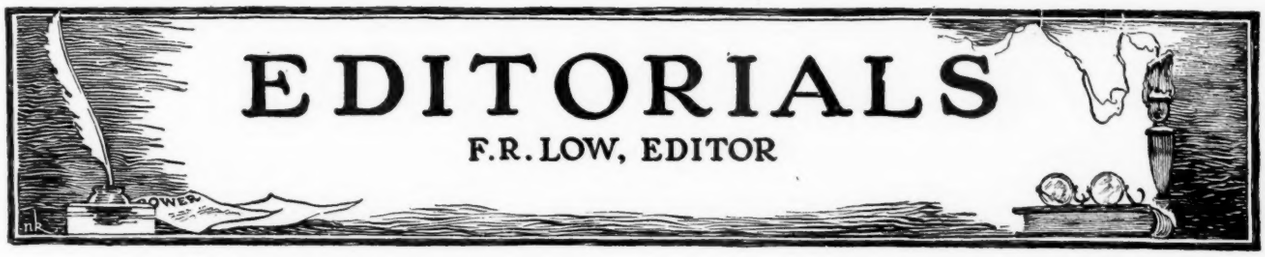


Fig. 6—Connection for testing watt-hour meter, Fig. 1, using a water rheostat for obtaining a load

meter to be slow on light load and nearly correct on full load. Also loose light-load plate will cause variation in light-load registration. Short-circuited current coil will greatly affect the light-load accuracy.

Fig. 6 shows the connections for testing the meter by using a water rheostat or some other form of resistance for loading the meter. One of the objections to this method is that the load current taken from the line is equal to that flowing through the meter coils. With the loading transformer, the line current is only a small fraction of the current flowing in the meter coils. Where meters are not of too large capacity and only a few are being tested, the resistance load has the advantage of being cheap and readily available.

The clinker grinders on underfeed stokers should be operated so as to keep the refuse moving down continuously. This should be maintained at a nearly constant level in the ashpit. Variations of the level in the pit cause variations in the amount of coke discharged into the pit, which in turn tend to increase the combustible in the ash. Extreme changes in the pit level are likely to cause clinkering. If the contents of the pit are suddenly lowered after having been allowed to become too high, a large amount of coke discharges into the pit from the fuel bed, which frequently results in the temperature of the refuse being raised to a point where the ash fuses and clinkers form. The level of the pit should be maintained such that the surfaces of the end grates or the stoker noses are well covered at all times with fuel, but the level should not be permitted to come so high that the thickness of the fuel bed on the stoker is unduly increased.



Industrial Plants Offer Big Field for High Steam Pressures

PRACTICALLY all the recent notable advances in steam pressures in this country have been made in the central stations. With every encouragement and facility for carrying thermal efficiency to the extreme limit of commercial economy, several such stations have considered it worth while to adopt steam pressures in the neighborhood of 550 pounds, while a few are giving serious attention to still higher pressures.

Competent consulting engineers are still divided on the question of the commercial advisability of such pressures in the present state of the art, but the weight of opinion seems to be swinging gradually in their favor for base-load plants favorably situated. In view of the difficulty of deciding between 350 and 550 pounds for the large central station it is not surprising that many engineers should jump to the conclusion that the higher pressures are not to be considered for the industrial plant. Yet some factors, at least, would apparently warrant higher pressures for industrial plants as a group than for the central stations as a group.

With few exceptions the former group is characterized by the utilization of part of the exhaust steam (or of bleeder steam), while the latter is characterized by operation at high vacuum.

There can be no comparison between the gain obtainable by increased pressures in these two cases. A plant exhausting to process at atmospheric pressure should show a percentage gain by a pressure increase from 250 to 500 pounds, practically double that obtainable in a station operating with a 29-inch vacuum. The higher the back pressure the greater the relative gain. It would appear that the rubber industry, for example, could well afford to use steam pressures as high as one thousand pounds (higher, in fact, as suitable boilers become available), at the throttle of turbines exhausting at considerable back pressure to process work. The gain in power production over operation at 250 pounds, would be enormous.

Unit Pulverizers in Small Plants

WHILE no distinct lines can be drawn at present, it is beginning to be apparent that central pulverizing systems are being installed in larger plants while unit systems are finding favor in small installations.

The essential requirements of a pulverized-coal system for a small plant are simplicity, low first cost, small maintainence and minimum attendance. The system must be simple and have few parts that may get out of order; unit pulverizers more nearly meet these requirements. Driers are seldom used with unit pulverizers, partly for the sake of simplicity but largely because of lower first cost, and low first cost is needed to make the investment an attractive one. A cheap machine may involve high maintainence charges that may greatly offset other advantages. Little is positively known of the cost of maintainence of many systems now on the market. Every plant owner would like to employ less labor in the boiler room, and if the particular system can reduce plant labor, so much the better.

Unit pulverizers are generally of small, compact design and can be accommodated in the usual aisle in front of the boilers. Furnace design will require more care and greater attention if serious difficulties are to be avoided. The possibility of restricting excess air is conducive to higher furnace temperatures with resultant higher boiler efficiencies, but this increased furnace temperature may be greater than the firebrick can stand, particularly if the ash fuses at a relatively low temperature and causes the walls to run down; hence the necessity for air-cooled or water-cooled walls.

There is a great need for accurate operating information and for data on efficiency, cost of maintenance, power requirements, labor, etc., in plants with unit systems. Experiences with these plants will prove of interest to increasing numbers of practical engineers. Such information will be helpful to all who have improved station economy as their first interest.

The Part Played by Brains

THE basic cause for the decidedly inferior operating results found in many plants is the lack of interest shown by those who are financially interested. The management is generally in the hands of men who have come up through the factory production or through the sales branches. Their chief interests lie in manufacturing cheaply and selling at a profit. Knowing little of the engineering of power plants, they naturally assume that the possession of a state or municipal engineer's license is prima facie evidence that the holder is in fact a capable man. A license is merely an indication that the engineer has satisfactorily answered a certain list of questions and has had a definite amount of experience. Just what the engineer's real capabilities amount to, is for the employer to find out.

Recently, three oil engines were installed in a power plant. Pains were taken to see that every needed device was incorporated in the plant layout, including a water softening system and exhaust pyrometers. The leads from each pyrometer were connected to a single twelve-point dial on the switchboard, and it was a matter of but a moment to check the exhaust temperature of all the engine cylinders in the plant.

A cylinder on one engine showed a temperature of about seventy-five degrees above the temperatures of the other two cylinders. The operating engineer seemed to take but little stock in the value of the instrument and made no attempt to adjust the engine mechanism to bring the exhaust temperatures into closer relationship. As counter to a suggestion that the higher temperatures indicated that either this particular cylinder was

getting more oil than the others or that the spray nozzle was dribbling, he emphasized his belief that it did not pay to alter any of the adjustments.

Here was a plant where money had been expended to supply instruments whose readings could be guides to the engineer, yet he failed to recognize their value or did not understand the probable causes of troubles when indicated.

The point to be emphasized is that new equipment alone will never result in an efficient plant. Brains are needed. The manager should ask himself the question, Is my engineer efficient, and am I paying enough to keep such a man? A negative to either part of this question calls for action by the management.

Six Jumps to Justice

OUR patent laws are based on the Constitutional provision giving to Congress the power to promote progress in science and the useful arts by allowing inventors and authors the exclusive control of their respective discoveries for a limited period. In the case of a machine the inventor is given seventeen years in which he may exclude others from manufacturing and selling equipment based upon his discovery, except by his permission, the object being to encourage inventors to disclose their inventions to the public, so that the best interests of the nation may be served. There is no question as to the soundness of the fundamentals of this idea, but in its administration conditions have arisen that leave doubt as to whether the inventor always receives the justice that this constitutional provision was intended to foster.

Conditions in the Patent Office have improved considerably during the last few years, but there remains much to be desired. Formerly, a period of about two years elapsed from the time the patent application was filed until it was taken up for consideration. The time has now been reduced to about seven months, which is a decided improvement. Although from the time the application is made until it is first considered is seven months, this does not mean that it has smooth sailing from then on, for there are many delays in its course through the Patent Office and the courts, if the latter have to decide the patentability of the device.

Under the present procedure in the Patent Office, if the examiner fails to allow the claim for a patent, the case may be appealed to the Board of Examiners, then to the Commissioner of Patents, then to the Supreme Court of the District of Columbia. then to the Court of Appeals and finally to the Supreme Court of the United States, a procedure that has been characterized as six jumps to justice. This machinery seems to be unduly cumbersome and costly for an institution intended to administer justice and encourage progress in science and in the use of arts. If the applicant for a patent finds that it is not allowed by the examiner, the wisest procedure, unless he feels he is able to stand the financial strain involved in the various appeals, is probably to quit while the quitting is good or he may find himself half way to justice and financially stranded.

At this time certain changes in procedure in the Patent Office could do much to improve conditions. One that has been suggested is to eliminate the appeal to the Commissioner. This would allow the Commissioner, who under present conditions has to devote the greater part of his time to hearing appeals, to give his attention entirely to administrative functions of his office, which are very important. To this suggestion the lawyers have objected, but the primary purpose of the Patent Office is not for the benefit of lawyers. In any consideration of its reorganization, the primary purpose for which the Patent Office was intended should be the paramount object, and if it is possible that the patent applicant is more likely to receive justice in three jumps than in six, then by all means three. Whatever may develop out of the present efforts to reorganize the Patent Office, it is evident that the Commissioner of Patents should be relieved of either his administrative duties or a large part of his judicial functions. Either of these duties are such as to require the attention of a capable administrator.

The President's action in transferring the Bureau of Mines from the Department of the Interior to the Department of Commerce, following the transfer of the Patent Office a few weeks ago, is in line with his expressed determination to reorganize the executive arm of the government. These transfers are expected to eliminate some of the waste, so stoutly arraigned by Mr. Hoover in his recent speech to the Chamber of Commerce. His well-known capacity for tackling big jobs and co-ordinating activities promises greater things for the Bureau.

Strange as it may seem, there are many operating engineers today who picture "pulverized" coal solely as something to be mixed with large-sized coal and burned on grates. The fact that coal may be burned in suspension would be real news to some who hold a first-class license. If you doubt this, try it on some of your operating friends who confine their technical reading to "Peppy Stories."

The number of researches and investigations now being conducted at the various engineering schools indicates that at last industry is making use of the school laboratories. Researches cover a thousand fields, from metal crystallization problems to the merits of multiple spark plugs in gasoline engines.

While machine manufacturers and engineers have given much thought to the design of efficient refrigerating plants, the same amount of study is not being given by the plant management to the problems of operation. It is most unusual to find a plant approaching anywhere near its possible efficiency.

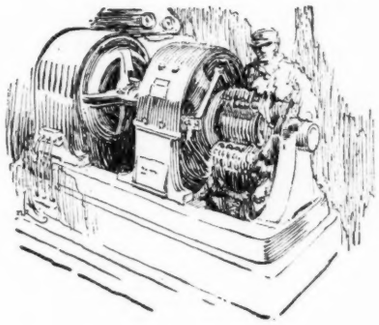
To many the word unaflow means a thing of high efficiency. As a consequence there are unaflow compressors, unaflow water pumps and unaflow gas engines, in none of which does the action of the fluid resemble that in the unaflow steam engine.

Those who contend that the Corliss engine is a thing of the past would be surprised to see a twelve-thousand-horsepower unit of this type that is now on the erecting floor of one of our well-known builders.

Indications are that the air preheater and the water-cooled furnace wall are here to stay. To what extent they will influence boiler design in the next few years is a question that many engineers are asking.

Indications point to higher rotative speeds and multi cylinders in steam-engine practice.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for April will be announced this month.

Improving the Operation of a Separator

In our plant there is a vertical separator located above a closed heater in an exhaust line from a steam engine, which removed the oil from the steam satisfactorily when the load on the engine was light, but when it was more than doubled, much of the cylinder oil passed through it and entered the boilers.

An effort was made to improve the operation of the separator by connecting a cold-water line to the regular drip pipe from the separator, the connection being made above the drain valve. Every morning before the engine is started, the cold water is turned on and the drain is flushed out. Then the drain valve is closed and water allowed to collect in the body of the separator as the glass gage is filled. The water is then shut off and the drain valve opened. After all cold water has passed to the sewer, the engine is started.

The arrangement of piping and the plan of operation have improved the operation of the separator.

New Haven, Conn. W. H. WAKEMAN.

Computing the Steam Consumption from the Temperature of the Return Water

The following method was used in a paper mill to determine the approximate steam consumption of two paper machines without using any meters, weighing or measuring devices except three thermometers. The driers were supplied with live steam and also exhaust from the engines driving the paper machines. The chief engineer concluded that the only way to determine the steam consumption of the various units was to install a portable steam-flow meter or a condensation meter on the return line. As neither of these devices was available, I evolved a plan that was accurate within 2 per cent, which is as close as some meters will record. A thermometer was placed on the return line from the paper machine to the receiving tank. The tank contained at all times a mixture of condensate and makeup water which constituted the boiler feed. The feed pump took water from this tank and pumped it through a closed heater into the boiler. On the feed-pump suction pipe there was a thermometer that indicated the temperature of the water in the tank. Another thermometer was placed on the condenser discharge pipe which supplied the makeup water. Our total boiler evaporation was 17,000 lb. of water per hour. The temperature of the condensate, measured as close to the tank as possible, was 209 deg. F. It was probably much higher at the point where it left the machine room, but the line was not insulated and with about 125 ft. of 1½-in. pipe uncovered there was considerable heat loss. The temperature of the makeup water was 120 deg. and the tank temperature was 161 deg. Now the 17,000 lb. of water per hour at 161 deg. consisted partly of condensate at 209 deg. and partly makeup at 120 deg. and I computed the percentages of each as follows: Total heat contained in 17,000 lb. of water at 161 deg. is $17{,}000 \times (161 - 32)$, or 2,193,000 B.t.u. Total heat in 1 lb. of condensate is 209 — 32, or 177 B.t.u. Total heat in 1 lb. of makeup at 120 deg. is 120 — 32, or 88 B.t.u.

Let X = condensate in pounds per hour; then $17{,}000 - X$ = makeup in pounds per hour.

$177\ X + 88\ (17{,}000 - X) = 2{,}193{,}000$ B.t.u.

Reducing to simplest terms, $177\ X - 88\ X + 1{,}496{,}000 = 2{,}193{,}000$.

Subtracting 1,496,000 from each side of the equation, $89\ X = 697{,}000$.

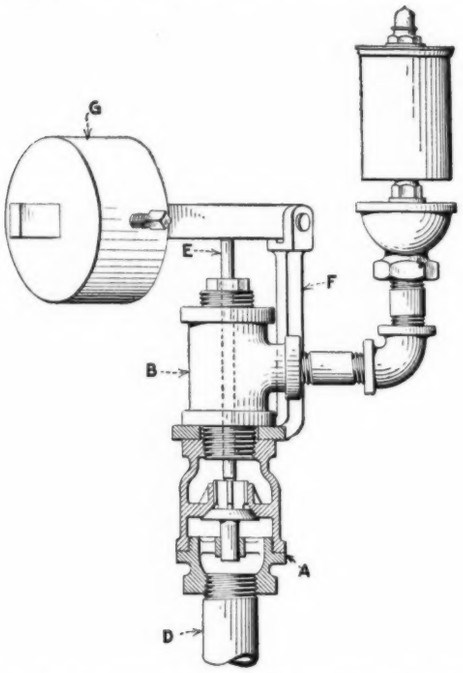
Therefore $X = 7{,}831$ lb. per hour, and the makeup would equal 17,000 — 7,831, or 9,169 lb. per hour.

For those not familiar with algebra the trial and error method will give approximate results. Take, for instance, two pounds of water as contained in the tank; the total heat content is 258 B.t.u., or 2(161 — 32). Suppose the condensate and makeup to be in equal proportions, then 1 lb. condensate plus 1 lb. of makeup gives a heat content of (209 — 32) + (120 — 32), or 265 B.t.u., but this is more than 258 B.t.u., so we must try a lower percentage of condensate and a higher percentage of makeup. Take 0.9 lb. condensate and 1.1 lb. makeup. The total heat content is 0.9 (209 — 32) + 1.1 (120 — 32), or 256.1 B.t.u. This gives too low a heat content, so we must try a different mixture. Take 0.92 lb. condensate and 1.08 lb. makeup. Total heat is $0.92 \times 177 + 1.08 \times 88$, or 257.88 B.t.u., which is fairly close. Since 0.92 lb. of condensate and 1.08 lb. makeup contain the same heat as 2 lb. of tank water, then the percentages are 46 per cent condensate and 54 per cent makeup. This gives 7,820 lb. of condensate and 9,180 lb. of makeup. The reason for studying this problem was to prove the claim that the manufacturing process took over 40 per cent of our coal, and that not over 60 per cent of the coal bill could properly be charged against the engines, for 7,831 lb. of condensate coming from the paper machines meant that 7,831 lb. of steam per hour must be generated to dry paper. ANDREW F. SHEEHAN.

Holyoke, Mass.

Low-Pressure Air Alarm

A number of years ago I was employed in a large office building where the elevator doors were operated by compressed air, the air being furnished by a motor-driven compressor in the engine room. The circuit breaker on the compressor motor circuit would occasionally open, and often before it would be noticed by



Vertical check valve in inverted position admits air to whistle when pressure falls

the engineer, the pressure would be too low to operate the doors; then someone would have to notify the engineer. To eliminate this inconvenience, we installed the alarm shown in the illustration.

A vertical check valve *A* was connected to the air line *D* in an inverted position, and on top of this was mounted a tee with the side outlet leading to a small whistle. In the other end of the tee a plug was placed with a hole through it for guiding a small spindle placed on top of the valve disk as shown. With this arrangement, as soon as the air pressure dropped to a certain point, the valve would open and pass sufficient air to blow the whistle.

While the possible applications of this alarm for a similar purpose may be limited, the same arrangement could undoubtedly be used for other purposes around the plant. C. H. Root.

Detroit, Mich.

Furnaces for Burning Wet Wood Refuse

Inasmuch as the question, What is the best type of furnaces for burning wet wood refuse? comes up from time to time, it occurred to me that my experiences along that line may be of interest to other readers.

I was employed several years ago as chief engineer and master mechanic by a big lumber and paper manufacturing company, where a large portion of the steam requirements of the various mills was furnished in burning wood refuse. The paper mills had a surplus of this material that was costing the company considerable money to dispose of.

In one of the smaller mills there were four 72-in. x 20-ft. return-tubular boilers. Three of them, equipped with dutch ovens, were burning wet wood refuse to operate two paper-machine engines developing about 250 hp. The fourth boiler was coal fired for cooking soda pulp. The operation of the wood-burning boilers was so unsatisfactory that the coal-burning boiler was doing most of the work.

Fig. 1 shows the design of the furnaces as originally installed. Their apparent fault was due to the small volume of the furnace, also to the restriction of the gas passages over the bridge wall and in the combustion chamber, choking the draft.

Fig. 2 shows the changes made in the settings of the furnaces. The volume was increased by moving the front wall out 12 in., taking another foot off the sloping bridge wall and lowering the grates 6 in. This increased the volume of the furnace of each boiler from 126 cu.ft. to 192 cu.ft., or 34 per cent. The bridge walls were opened up from 12 to 24 in., all the earth fill removed from the combustion chambers, and when the boilers were put in service again, there was an ample steam supply for all the requirements of the paper mill. The fuel was rossed shavings from pulp wood with some slight additions in edgings and slabs from one of the sawmills. This fuel averaged 48 per cent moisture content as air-dried fuel. There was also a saving of 10 tons of coal weekly in the coal-fired boiler, besides

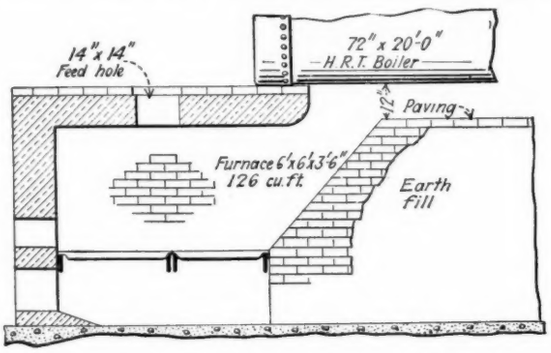


Fig. 1—Arrangement of furnace as originally installed

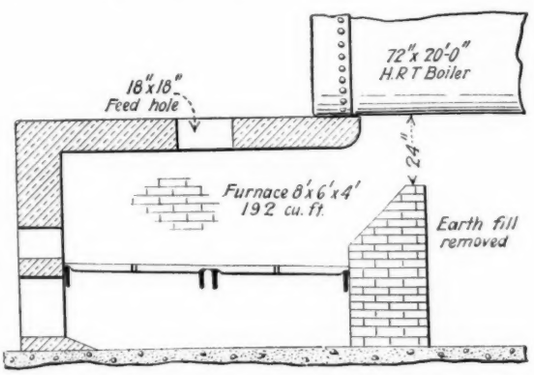


Fig. 2—Changes made in height of bridge wall and size of furnace

dispensing with the services of three firemen. No tests for efficiency were carried out owing to the variation in the weight of the fuel and lack of facilities for doing any testing. But having a sufficient steam supply at all times and a more uniform production from the paper machines, several thousand dollars was saved yearly.

Another large paper mill of the same company had a problem of getting rid of about 2,700 cu.ft. per hour

of this rossed pulp-wood shavings from thirty-six barkers, that was costing the company $50 daily for cartage, and the surrounding country was being rapidly filled up with it. We could have erected a burner for disposing of it, but the cost was about equal to a boiler plant of the same burning capacity. It appeared to be too valuable to dispose of in a burner, considering the success we had obtained utilizing it as a fuel in one of the smaller mills. Accordingly, plans were made to burn it in boiler furnaces. At the start it was realized that we would have to make this a separate unit entirely, as the eight coal-fired boilers of the plant were equipped with superheaters and economizers. It would not be practical to put the gases from the wood-fired boilers into the smoke flue from the coal-fired boilers, owing to the moisture content of the gases and the deleterious effects they would have on the economizers. Two 5,000-sq.ft. horizontal water-tube boilers were purchased and installed with dutch oven type furnaces as shown in Fig. 3. Each boiler furnace was divided into two parts by a partition wall. This wall had a twofold purpose—to assist in supporting the furnace arch, and after being heated up, to assist in igniting the mass of wet fuel by driving off the moisture content. The fuel consisted of wet wood bark, wet sawdust and wet rossed wood shavings from pulp wood. It varied in moisture content according to the season of the year and the condition of the weather from 39 to 57 per cent, and averaged in weight about 5.84 lb. per cu.ft. air-dried.

In estimating the probable fuel value, there were no data that could be used in similar conditions as far as evaporation in the boilers was concerned per pound of fuel, but if we could burn this material as fast as it was delivered by conveyor from the wood preparing room, the cartage charge would be saved plus other incidentals, and at the lowest estimate, we would evaporate 2 lb. of water per pound of air-dried fuel. As the feed water leaving the economizer had a temperature of 250 deg. F. and would be used for feeding the wood-fired boilers, there would be the possibility of saving on the coal consumption of the coal-fired plant.

The two wood-fired boilers were served by a large smokestack that gave 1.3 in. of draft at the smoke flue, 1.1 in. in the combustion chamber and 0.8 in. over the fire. As will be noted, each furnace had a volume of 482 cu.ft. or 1,928 cu.ft. for the four furnaces, or room in the furnaces for 72 per cent of the volume of shavings that would be delivered per hour. The furnaces not only burned this fuel, but if there happened to be any interruption in the supply from the wood room, the dampers had to be closed to maintain fire in the furnaces for starting up again. Two men operated the boilers on each shift. As they were taken off two of the coal-fired boilers, there was no addition to the fireroom crew and a saving of 18 tons of coal daily was made.

The boiler feed was metered and varied from 16,500 to 26,000 lb. of water per hour, which represents a rating of 48 to 75 per cent on approximately 2,700 cu.ft. of fuel per hour, with an average of 46 per cent moisture content. At times it crowded things around the furnaces to take care of it and no doubt we received this amount continuously, as it was the average quantity found on investigation while the matter was being studied.

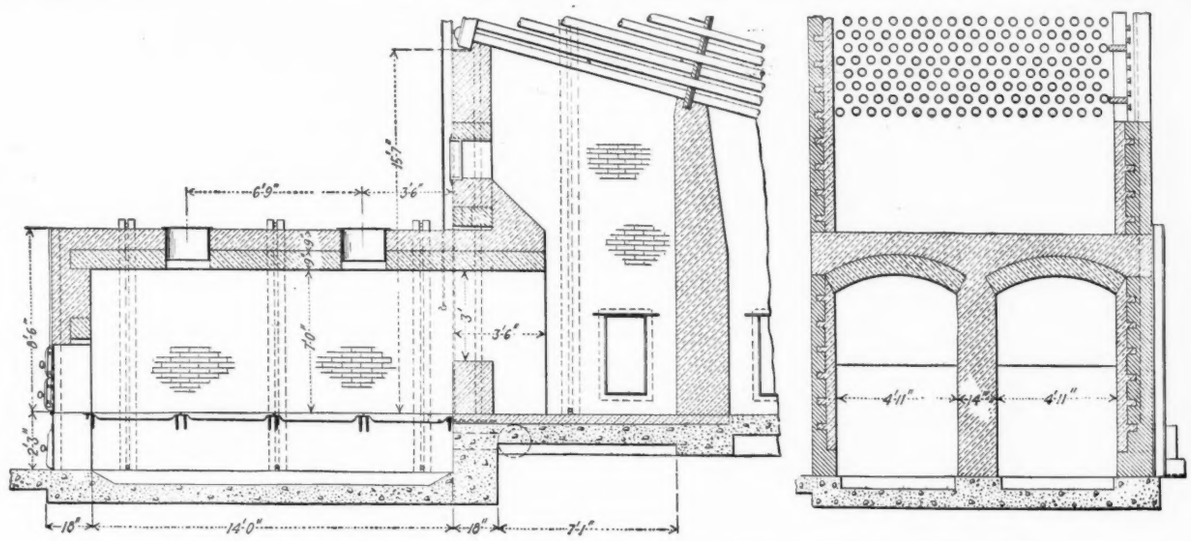


Fig. 3—Design of furnace and setting used with 5,000-sq.ft. water-tube boiler

The plant cost $24,500 to install and saved in the first season of operation, using the cost of the previous season to dispose of the fuel plus the amount of coal saved daily by closing down two coal-fired boilers, $18,500 or 75 per cent of the initial cost.

The grate is an ordinary flat grate bar, made rather light with about 45 to 48 per cent air space. No objectionable riddling was noticed. After a week's run about one coal barrow of ash would be removed from the ashpits that consisted mostly of sand or similar material, and about the same amount was removed from the back connections or combustion chambers.

The castings for the feed holes had to be renewed after the first season as they were badly warped. Some slight repairs were made to the furnace arches around the feed-hole castings, due, no doubt, to the warping of the casting and the constant closing of the doors. The brickwork of the furnaces and arches had a high glaze after the season's run. Otherwise, the installation was entirely successful. Another feature of this installation is the fact that no matter how hard the boilers are worked, no sparks are emitted from the top of the stack, as we had reason to fear.

J. F. NAGLE.

Brooklyn, N. Y.

Comments from Readers

Producer Gas Engines

I was much interested in the discussion in *Power*, May 5, by L. D. Anderson, on producer-gas engines. This prime mover seems to be neglected on this continent, although used extensively in Europe and other parts of the world.

For several years prior to the war I was employed building these plants and also operated one for some time. This particular one was a 60-hp. unit and ran a small sawmill. When first installed, it would burn smokeless fuel only, such as coke and anthracite. Soon after, the manufacturer designed a producer that would use anything capable of making an incandescent fire. One of these was installed in the sawmill to replace the anthracite producer, and it ran satisfactorily for years, on metal sweepings, sawdust, bark and chips.

The sawmill being near to the makers, they tried other fuels with good results, these being peat, lignite and other low-grade coals, oil-seed husks, cocoanut bristles, linoleum cuttings, etc. This engine gave a thermal efficiency approaching the oil engine.

Units running into hundreds of horsepower were being projected, but were delayed by the war, and I have no knowledge of later developments. The producer-gas engine does produce power cheaply.

Toronto, Canada. RALPH LILL.

Collector Rings on Synchronous Motors Wear Unevenly

Referring to Mr. Elderkin's letter in the May 12 issue relating his experience with the collector rings of a synchronous motor wearing unevenly, we have not had as much trouble with these as with the collector rings of the rotating fields of our turbo-generator sets. We understand from the representatives of the manufacturer that it is standard practice to reverse the field connections at regular intervals to equalize the wear of the negative ring. This wear does not seem to be confined to collector rings, as voltage regulators of the Tirrell type are provided with reversing switches for the contacts, which are supposed to be changed daily.

The wear of collector rings does not seem to affect all machines alike, not even similar machines in similar service. For instance, we have one 1,000- and one 1,250-kw. three-phase 60-cycle 440-volt 3,600-r.p.m. turbines with direct-connected exciters. On the 1,000-kw. machine we have had some exciter trouble, principally sparking at the commutator until it apparently was thoroughly aged and then reground at full speed, but the difference in wear of the collector rings was slight, whereas on the 1,250-kw. machine we have had no exciter trouble, but the difference in wear on the collector rings is quite noticeable. We have a 200-hp. 450-r.p.m. synchronous motor with direct-connected exciter, but have noticed no signs of wear on the cast-iron collector rings of the field with which it is equipped. The commutator of the direct-connected exciter of this motor sparks a little, chiefly owing to vibration we believe, as the commutator does not seem badly affected.

In another plant a 1,200-kw. 1,800-r.p.m. three-phase 60-cycle 2,300-volt machine with cast-iron collector rings showed considerably more wear than a 2,500-kw. 3,600-r.p.m. unit, although the latter ran a much larger portion of the time. Both these machines were excited in parallel from a separately driven exciter, sometimes a motor-generator set, sometimes a steam-turbine set.

Mr. Elderkin's explanation of uneven wear across the faces of commutators due to a phenomenon of this sort seems hardly reasonable, as all the brushes across the commutator at each position are of the same polarity so that the commutator should be equally affected across its whole width under the negative brushes and correspondingly less affected under all the positive brushes so that if the brushes are set at all staggered, as is often recommended, the wear should be evenly distributed.

Our experience has been that grinding commutators true at running speed and eliminating vibration so that brushes may be kept in proper contact with the commutator with a minimum of spring tension, will give long-continued operation without trouble, using, of course, suitable brushes and reasonable care to keep the commutator clean and brushes free in the holders.

New Haven, Conn. H. D. FISHER.

Temporary Covering for Back Connection of Return-Tubular Boiler

Reading about "Temporary Covering for Back Connection," in the Question and Answer Section in the April 21 issue, brought to mind an experience I had along this line some time ago.

I was on the morning shift in a boiler plant consisting of three horizontal return-tubular units supplying steam for a turbo-generator. About 2 a.m. the back arch of one of the boilers dropped down and smoke and fire shot up. I cut out the fire under the boiler at once and increased the fire under the other two. In looking around outside the boiler room for something to replace the arch, I noticed a few sheets of corrugated iron and some short pieces of 2-in. pipe, so decided to use these to close the opening temporarily.

I placed three of the pieces of pipe across the opening and then one sheet of iron. In about fifteen minutes from the time the arch failed I started the fire again under the boiler and soon had the boiler picking up its share of the load. Then I got some sand from a pile in the yard and spread a layer of it over the sheet iron and on top of this I placed another sheet of iron and a layer of sand.

This temporary repair stood for over two weeks, until the boiler could be taken out of service long enough for a permanent repair. THOMAS W. WOOD.

Taft, Calif.

Eliminating Dangerous Conditions in the Power Plant

In the May 12 issue A. A. Fette describes what might have been a severe accident on account of the necessity of sending an operator to the top of the boiler in order to cut in on the steam line. It would appear from the sketch submitted by Mr. Fette that the boiler in question was fitted with a non-return angle stop and check valve, which should preclude the necessity of the operator's going to the top of the boiler to cut it into service. I know of instances where non-return stop and check valves have remained in first-class operative condition for fifteen years and not once during that time was it necessary to cut the boiler in by hand.

Even when it is necessary to close the gate valve ahead of the non-return, it can be opened before a fire is started in the boiler, which places the non-return valve in commission ready to operate when the pressure has become equal to that on the main steam header.

Louisville, Ky. JOHN F. HURST.

Passing the Buck to the High School

In reading the editorial in the March 24 issue, entitled "Engineering Students" I felt that it should not be allowed to pass without some comment.

As a people we have a mania for telling the other man how to run his business. College professors are not immune, and whenever a group of them get together to discuss their undergraduates, they first bewail the present low standards, the lack of preparation on the part of the students, and the slackness of the high schools. They praise the students of ten and twenty years ago when the high-school graduates who went to college were men. Then having taken a gratuitous slam at the high school, they can settle down to the real business of the meeting, which is to pat one another on the back, tell what noble work they are doing and devise ways and means for perpetuating their errors and antiquated methods.

If the problems of student preparation and elimination are to be solved, some facts must be faced:

1. Many students should and do graduate from high school who are not intelligent enough to do college work as our colleges are now run. Also, many of these students have a desire to go to college and their parents have money enough to send them there.

2. The present method of selecting those students who will be allowed to go to college shuts out a few who should be allowed to go and allows a large number to enter who cannot do college work (at least 30 per cent of the total who get in).

3. It is highly probable that the present educational philosophy of engineering professors and engineering schools would not stand the light of a free and frank discussion. For instance, a new instructor in the mathematics department of one of our large engineering schools was instructed at the beginning of the year that he was to flunk 40 per cent of his students.

4. It is highly probable that the work in engineering schools is poorer than that in high schools, that their equipment is inferior, that their teachers are not as well prepared or of as high a caliber, and that their graduates are subjected to the same criticism. I should like to see some comparative measurements made.

5. The high schools can and should paddle their own canoe. The colleges cannot ethically ask them to become preparatory schools.

6. Much of the poor work done in high school can be traced to the requirements and interference of the colleges.

7. Many colleges mistake hard courses for good courses to the extent that a student's grades in college bear little relation to his ability.

The high schools are getting from under the college thumb, and considering that they are tax supported and that the college requirements are out of touch with our culture, it is well that they are doing so. Do the results achieved prove that the colleges have the requisite wisdom to dictate to the high schools? The facts of the case seem to indicate that the high schools are putting more effort and intelligence into the solution of their problems than are the engineering schools.

The colleges took a stand, that was hard to defend and one from which they have slipped a little, that a student was not fit to do college work until he had studied so many units of a foreign language, so many units of mathematics, a science, etc. These requirements in the main are plain bosh and having sown tares, they should not expect to reap good grain. The colleges really want students of intelligence with good study habits, ability to concentrate and a certain attitude of mind. The best way not to get them is the one they are following. The college authorities must be brought to realize that men are not intellectually equal. Over half the children in this country have enough intelligence to do the required work and pass the entrance examinations, while it is probable that not more than half of these could do the college work after getting in.

Which would make the better engineering student, a boy of 18 with an I. Q. of 130 and no more training than that required to read, write, speak, and understand common every-day English and to handle the fundamentals of arithmetic freely through percentage, or a boy of 20 with an I. Q. of 105, who has just completed the required number of units in high school and taken and passed the college entrance examinations in mathematics and the other required subjects? The first student could not pass the entrance examinations and would be shut out or required to undergo further preparation. Yet if he had good work and study habits and was interested, he could and would do the college work. The second student did pass the examinations, but no matter how many other favorable factors he could bring to bear, he could not do the work required at most colleges.

It is time for the engineering schools to forget that the high schools may not be quite perfect and concentrate on solving their own problems in a scientific manner. Why not make out specifications for their students on a basis of what they can get and not on an ideal which has never been checked up. Let us put our specifications in terms of the tensile strength, modulus of elasticity and Brinell hardness of our student raw material instead of the amount of machine work that has been done on him. Having done this, let us take any student who can measure up to these specifications, even if he has never gone to high school. Then the colleges could say to the high schools, "This is what we want. Do your work in your own way as you see fit and we will not interfere. But recommend to us only those of your students who come up to these specifications." DAVID E. DAVIS.

De Land, Florida.

Questions and Answers

Conducted by

Franklin Van Winkle

Greater Clearance of Slide-Valve Engines

Why must slide-valve engines have more cylinder volume clearance than Corliss engines? H. J. T.

In a slide-valve engine the steam passages must be longer, making more waste clearance space necessary than for the Corliss type of engine, in which short admission and exhaust passages are obtained by having separate steam and exhaust valves close to the ends of the cylinder. Horizontal slide-valve engines are not so well adapted to prompt drainage of water from the cylinder as horizontal engines of the Corliss type, for in the Corliss engines the exhaust valves are placed in the bottom of the cylinders, and during the discharge of the exhaust the cylinders can be drained of water, whereas in the slide-valve engine more piston clearance must be provided to make room for any water that is not swept out with the exhaust.

Discharging Condensate Derived from Superheated Steam

Can steam at 80 lb. gage and superheated 50 deg. F. be passed through a machine and delivered at the same pressure and temperature to a drain line and be discharged as condensate through a trap? F. J. S.

If any heat is absorbed by the machine, the steam could not be discharged from it without reduction of temperature. Before any of the steam is converted to condensate, there must be sufficient liberation of heat to reduce its temperature to that of dry saturated steam of the pressure present, and there also must be removal of the latent heat of evaporation of that pressure. As a trap is assumed to handle only water, cooling to the saturation temperature and condensation must occur before or after the steam reaches the drain pipes.

Operating Corliss Engine Much Underloaded

In starting a new plant, the non-condensing Corliss engine for several months will carry less than one-fifth of the full load for the engine. The intended boiler pressure is to be 110 lb. gage. Would it be better to carry this full boiler pressure or operate at a lower pressure? J. R. G.

In any case the initial pressure of steam supplied to the engine should not be so high that the shortness of cutoff will result in expansion below the back pressure of the exhaust, as that causes injurious pounding of the exhaust valves and is more wasteful of steam from cylinder cooling than the advantage of expansion. In addition there will be better speed regulation from operating through a wider range of governor action. Hence, for the temporary light load, carry a boiler pressure 20 to 30 lb. higher than necessary to prevent expansion below atmosphere and obtain the balance of the desired reduction of initial pressure by throttling.

Change of Lead with Fixed Eccentric

In a slide-valve engine how can the lead of both ends be increased if the eccentric is keyed on the shaft? R. L. G.

The lead would be increased by advancing the eccentric, and, where the eccentric is keyed on the shaft, this could be accomplished by fitting the eccentric with an offset key to give the desired amount of advance, thus hastening all valve events. Another method of increasing lead would be to reduce the outside laps of the valve or by removing a portion of the admission edges of the steam ports, but either operation would have the effect also of making the cutoff later.

Relative Feed Water for Same Boiler Capacity at Higher Pressure

What would be the relative quantity of feed water used at 180 deg. F. in the development of the same boiler capacity when steam is generated at 125 lb. gage as compared with 80 lb. gage? C. W. M.

The total heat above 32 deg. F. contained in a pound (weight) of dry saturated steam at 125 lb. gage, or 140 lb. per sq.in. absolute, is given in Marks and Davis Steam Tables as 1,192.2 B.t.u., and with the feed-water temperature 180 deg. F., each pound of water for conversion into steam would require 1,192.2 — (180 — 32) = 1,044.2 B.t.u. The total heat contained in a pound of dry saturated steam at 80 lb. gage, or 95 lb. per sq.in. absolute, is found from the steam tables to be 1,185.4 B.t.u. above 32 deg. F., and for its generation from feed water at the temperature of 180 deg. F. each pound of feed water would require 1,185.4 — (180 — 32) = 1,037.4 B.t.u. Therefore the development of the same boiler capacity with steam generated at the pressure of 125 lb. gage would require the evaporation of 1,037.4 ÷ 1,044.2 or 99.3 per cent as much feed water as for the evaporation at 80 lb. gage.

Effect of Positive Lap of Steam Valves of Double Eccentric Corliss Engine

What would be the effect on the running of a double-eccentric Corliss engine with the steam valves given the same lap when the wristplate is in central position as we would give the steam valves of a single-eccentric Corliss engine of the same dimensions? P. E. M.

On a single-eccentric Corliss engine the eccentric is set forward of the 90-deg. position to obtain earlier release and compression, and it is necessary for the steam valves to have lap so they may be held shut until opened to obtain the desired amount of lead. This advancement of the eccentric reduces the fraction of stroke within which the steam valves can be disengaged for cutoff before the wristplate reaches the end of its swing to one side of the central position, and therefore

reduces the period before disengagement to less than one-half stroke. In a double-eccentric Corliss engine of the same size, with the steam valves given the same lap when the wristplate is in central position and the eccentric set to give the same lead, the latest point of stroke at which disengagement for cutoff could occur would be the same as for the single-eccentric engine. But if the eccentric had been set behind the 90-deg. position so disengagement might occur after one-half stroke, then the same lap would hold the valve closed until some time after the beginning of the stroke. In other words, there would be late admission.

Foaming of New Boiler

A new 72-in. by 18-ft. return-tubular boiler, when put into commission in a battery with two others of the same dimensions, shows considerable foaming. May this not be due to oil left in the boiler, and if so would not the oil endanger burning of the sheets over the fire? *L. D. C.*

Foaming may be caused by oil, but it is not likely that sufficient oil is present from the operations of the boilermaker to cause injury from burning. Part of the foaming could be caused by loosening of dirt and scale from the metal surfaces. The boiler should be blown down and washed as soon as possible, and if any signs of oil are present before the washing, it should be refilled with clean water to which has been added about 15 pounds of soda ash and then boiled off for about 10 hours with only sufficient fire to hold at 2 to 5 lb. gage pressure, and again blown off and washed out before being put into use.

Heating of Armature Bands

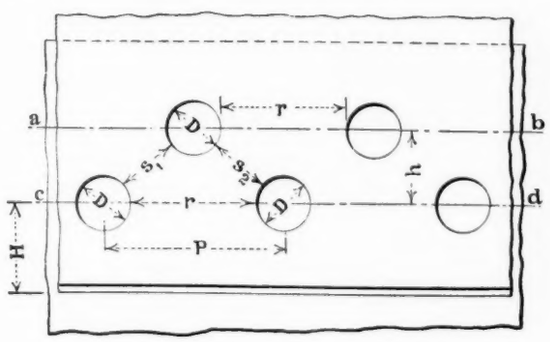
Some time ago I had to renew a band on a compound-wound interpole 8-pole generator. For making the band, which was about 2 in. wide, steel wire was used and this was insulated from the core with mica. After the machine was put into service, the band soon became so hot as to melt the solder. This band was removed and bronze wire was used, but the results were as unsatisfactory as before and the band was removed, believing it might get loose and damage the armature. In the third attempt to band the armature, the band was divided into two sections, each less than one inch wide, and steel wire used again. This arrangement proved satisfactory. Why did the band become heated? *L. C. R.*

Heating of armature bands is due largely to the sections of the bands under the polepieces cutting the radial lines of magnetic force passing into and out of the armature core, which in turn causes eddy currents. The sections of the band under north poles will have a voltage generated in them in one direction parallel to the axis of the armature shaft. Under the south poles the direction of the voltage generated in the band sections will be opposite to that under north poles, which is identical to what occurs in the conductors of the armature winding. Since the band is continuous, closed circuits are formed between the sections under the different poles, with the result that the current circulates in the bands in much the same way as in the squirrel-cage winding of an induction motor. The wider the bands the higher the voltage generated in them will be, but the resistance of the circuits in which the currents circulate will be only slightly increased, consequently the current will increase practically as the voltage. Since the heating increases as the square of the current, doubling the current will produce four times the heat. From this it can be readily seen how increasing the width of the bands may cause a condition that will produce excessive temperatures in them. In some types of machines it is advisable to keep the bands down to about one-half inch in width. Where wider bands are required, they should be made in sections.

Back Pitch of Riveted Joints

What governs the distance between parallel rows of rivets of a staggered riveted joint, and how much should the sheets lap outside of the rivets? *W. B.*

For definite calculation of the strength of a joint the tearing of the plate should be assumed to take place between rivet holes *DD* along a line of rivets *ab* or *cd* in the sketch, rather than along the oblique lines indicated by the dimensions $s_1 s_2$. In a series of joints designed and tested, where the sum of the diagonal pitches was taken with increasing ratio to the value of the pitch *P*, it was found that with 10 or 15 per cent



"Back pitch" of riveted joints

more area on the diagonal pitches the joint nearly always would tear along the line given by the dimension *r*.

The A. S. M. E. Boiler Code, paragraph 182, provides that the distance *h*, or "back pitch," measured at right angles to the direction of the joint, shall have the following minimum values:

(a) If $\frac{P}{D}$ is 4 or less, the minimum value shall be $2D$.

(b) If $\frac{P}{D}$ is over 4, the minimum value shall be $2D + 0.1\ (P - 4D)$,

where P = pitch of rivets, in.; and D = diameter of rivet holes, in.

The A. S. M. E. Boiler Code, paragraph 183, provides that on longitudinal joints the distance *H* from centers of rivet holes to the edges of plates, except rivet holes in the ends of butt straps, shall be not less than $1\frac{1}{2}$, and not more than $1\frac{3}{4}$ times the diameter of the rivet holes, measured from the center of the rivet hole to the calking edge of the plate before calking, and that the plate edge shall be beveled to an angle not sharper than 70 deg. to the plane of the plate.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication.—Editor.]

American Boiler Manufacturers Association Convention

THE Thirty-seventh Annual Convention of the American Boiler Manufacturers' Association, held at the Glen Springs, Watkins Glen, N. Y., June 1, 2, 3 was conceded to be one of the most interesting in its history.

The address of President E. R. Fish started with a frank admission that the industry was hampered with overcapacity. The tendency on the part of industrial establishments to purchase their power, the greater pressures and capacities at which boilers are being run, tend to restrict the number of new boilers required. The demand is fixed by the steam-making requirements of the country and cannot be created as in the case of a new breakfast food. No doubt it is good management in many cases to purchase electric power, but undoubtedly in many cases the decision to do so is reached through the salesmanship of the agent of the utilities rather than by an engineering analysis of the facts in the case.

The remedy appears to be in the direction of some consolidation or reorganization whereby the best organized, best managed and best equipped shops and those occupying the best strategical positions shall be continued and used to handle the available business at the best efficiency. The increased sizes demanded and pressures carried make necessary the use of expensive machinery with which it is economically unsound to have a large number of shops equipped with low use factors and large overhead per unit of production.

The address dealt with the relations of the A.B.M.A. to other associations, was thoughtfully prepared and received with serious interest.

The report of the secretary-treasurer showed the Association to consist of 70 active, 23 associate and 2 honorary members. The active membership has been increased by two companies during the past year.

C. W. Obert, reported for a committee appointed at the Cleveland meeting in February to consider Caustic Embrittlement:

"The phenomenon of crystallization and cracking of boiler plate at or near the seams—not due to corrosion or wasting away of the plate but rather from some very different action—has been observed and known for upward of 30 years. The earlier experiences, wherever studied, were found to be characterized by the fact that: (a) the effect on the plates was in all cases below the water line: and (c) they practically all occurred in boilers using artesian well water.

"During the past 10 or 15 years more pronounced examples of this trouble have arisen which have indicated that it may under certain circumstances prove a dire menace to the safety of boilers. In one case a new water-tube boiler drum cracked from end to end practically its full length, after only six months of use. In other cases it has been found that upon detection of this trouble in one boiler, further examination has revealed that the other boilers in the same plant have been similarly affected and their joint and shell strength greatly reduced. A common indication of this phenomenon of crystallization is the snapping off of rivet heads at the joints affected. The rather mysterious and almost spectacular nature of these troubles have disturbed both manufacturers and users of boilers alike, and the manufacturers of the boiler plate are taking a keen interest in the investigations now under way."

The report enumerates the studies that have been made of the subject by the United States Navy; by Prof. S. W. Parr of The University of Illinois, and related in Bulletin 94 of the Engineering Experiment Station: by Prof. Henry M. Howe of Columbia University; by a plant manufacturing caustic soda; by Dr. R. S. Williams and V. O. Homerberg at the Massachusetts Institute of Technology, by C. S. Stromeyer of England; by J. H. Andrew at the University of Manchester, England and others, and concludes:

"The theory has been advanced that in the absence of sulphates in the boiler water, sodium hydroxide formed in the boiler saline may, by some corrosive action, accelerate the formation of cracks in overstressed material. This theory is based on the following facts: Cracks have been found in leaking riveted seams of a small number of steam boilers fed with natural artesian well waters high in sodium carbonate and very low in sulphates, and in certain geographical districts in some boilers fed with condensed steam from caustic evaporators, and in some boilers fed with water distilled from sea water to which considerable amounts of sodium carbonate were added. Others contend that such cracks may be entirely explained by faulty material or excessive internal stresses in the plates resulting from the manufacture or the operation of the boiler and by incorrect thermal or mechanical treatment of the plates, or by several of these causes combined. Nevertheless, the adherents of this theory suggest the maintenance of the sodium sulphate-carbonate ratio stated in Par. CA-5 of the A.S.M.E. code for the care of boilers in the hope that it will be beneficial and will help to decrease the number of cracks in riveted seams.

Charles E. Gorton reported for the Uniform Boiler Law Society, and president Joseph F. Scott and secretary-treasurer C. O. Myers for the National Board of Boiler and Pressure Vessel Inspectors.

Reports from many administrative and other committees upon subjects of less general interest were received and discussed. The outstanding features of the meeting were addresses by Dean Dexter S. Kimball of Cornell University on "Industrial Democracy"; by David Moffat Myers on "Power and Heat for the Small Plant," and by Wm. H. Jacobi of the Springfield Boiler Co. on "Guarantee of Boiler Performances." These papers will have larger treatment in future issues of *Power*.

Charles L. Huston of the Lukens Steel Co. read a paper on the "Tensile Strength and Ductility of Steel Plate and the Tetmayer Formula for Figuring Allowable Stresses." This was a representation of the article by Mr. Huston appearing in *Power* May 20, 1924, with some supplementary tests. The Tetmayer formula uses the product of the tensile strength and the percentage of elongation as the gage of the quality of boiler plate and gives allowable working pressures not materially different from the commonly used formula based on the tensile strength alone but without the urge to use plates having high tensile strengths but inclined to brittleness.

At a meeting of the Horizontal Return-Tubular section, W. A. Drake of the Brownell Co. read a report for the Sales Promotion Committee of the section deploring the failure to use exhaust steam for heating and process work and pointing out that where such a demand for exhaust steam exists the power may be had practically as a by-product. We shall give the report more extended attention later.

George S. Bach, Union Iron Works, Erie, Pa., was elected president for the ensuing year. Notwithstanding the prominence of Erie as a boiler manufacturing city this is the first time it has been honored with this office.

The other officers elected were: vice-president A. R. Goldie, Babcock-Wilcox, Goldie-McCulloch Co., Galt, Ontario, Canada; secretary-treasurer, H. N. Covell, 7 East 19th St., Brooklyn, N. Y.; executive committee, E. R. Fish, the Heine Boiler Co., St. Louis, Mo.; G. S. Barnum, the Bigelow Co., New Haven, Conn.; F. G. Cox, Edge Moor Iron Co., Edge Moor, Del.; W. C. Connelly, the D. Connelly Boiler Co., Cleveland, Ohio; W. A. Drake, the Brownell Co., Dayton, Ohio; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler, Co., Kewanee, Ill.; A. G. Pratt, the Babcock-Wilcox Co., New York City; M. H. Broderick, the Broderick Co., Muncie, Ind.

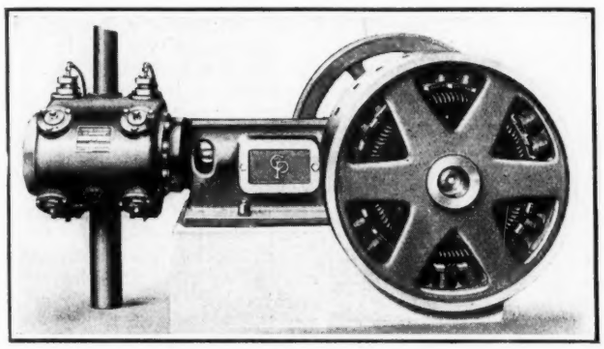
Resolutions of sorrow at the death of vice-president, E. C. Fisher, and sympathy for his family; of thanks to retiring president, E. R. Fish, and to the management of the Glen Springs Hotel were passed.

The usual golf tournaments were played and the prizes awarded at a banquet, in presiding over which President Fish demonstrated his ability to conduct proceedings in the lighter as well as the more serious vein. He was presented with a chronometer clock for his yacht by the members in recognition of his two year's service as president.

New and Improved Equipment

Chicago Pneumatic Synchronous-Motor-Driven Air Compressor

A direct-connected synchronous motor driven flywheel type of air compressor has been brought out by the Chicago Pneumatic Tool Co., New York City. This type of machine is available in sizes ranging from 139 to 1,000 cu.ft. displacement and for discharge pressures of from 100 to 125 pounds.



Compressor with direct-connected synchronous motor

The synchronous motor used with this new line of compressors was developed by the Ideal Electric & Manufacturing Co., Mansfield, Ohio, and is known as the flywheel type and is especially designed for single straight-line air-compressor operation. The motor is designed with the rotating element outside the stator, which is mounted in a cradle support bolted to the compressor frame. The outer periphery of the rotor forms a flywheel, the surface being crowned to permit belt driving an exciter or other auxiliary.

The air gap of the motor is relatively small, and to enable this being maintained the stator has been designed so that the magnetic pull is upward, and in addition the main bearings are fitted with removable die-cast bushings, which are readily renewable.

In the new design weight and, consequently, cost have been reduced. The floor space required to accommodate such an installation is less than if belted to a lineshaft or for a short-belt motor drive.

"Therminsul" as an Insulating Medium

The Minwool Company, of Kalamazoo, Mich., is bringing to the attention of the power field the insulating material known as "Therminsul," which for some years has been manufactured by the Insulating Products Company, of the same city. Development of this product has in the last few months revealed several uses of interest to the power field.

"Therminsul" is a felted block of pure mineral or rock wool. It is as firm and as easily handled as magnesia, yet is claimed by its manufacturer to possess greater insulating efficiency. In the manufacture of this product, by patented process, the wool is suspended in water and blown against a screen in such a way as to produce a felt of the material. This process does away with the use of metal lath or wire sewing. In application to boilers and boiler tops "Therminsul" is applied in the same manner as magnesia, is covered with a wire netting, and a plaster surface of insulating material troweled on. On boiler tops the addition of portland cement to the insulating cement will give the insulation a hard durable surface which will support all necessary weight.

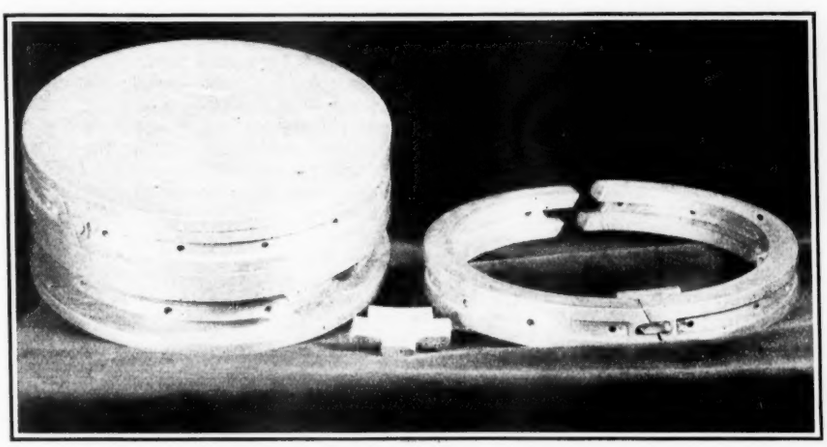
Application of this product to breechings is made without the use of the metal lath now generally used between the insulating material and the metal surface. It is applied directly to the breechings and covered in much the same manner as any other material. It is used also as an insulating medium in boiler settings and for the insulation of all kinds of industrial ovens.

Gibson's Piston and Rings

To remedy the defects of the average steam-engine piston rings of large diameter by the elimination of such contrivances as springs, etc., John L. Gibson, 32 Broadway, New York City, applied for a patent on a ring embodying unusual advantages.

The main feature of the device is that it does not depend on springs for its tightness, but is given the correct pressure against the cylinder wall by the pressure of whichever fluid may be introduced in the cylinder — steam, water, oil, ammonia or gas.

The balancing is arrived at in the following manner: A series of ports on the top and bottom sides of piston admit the full pressure to the back grooves of the rings. A series of holes through each segment of ring permits the steam to act on the groove in the outer surface of the ring. Owing to the differences of the areas of the inside and outside grooves the ring is pressed against the cylinder walls; the amount of the pressure depends on the areas of the grooves and may be made any value desired. The center chimes are cut away to receive tongue pieces, one of these being shown in the illustration between the piston and ring. The tongues are so constructed as to make the ring practically the same as if it were of single-piece construction. The segmental parts overlap the tongue pieces, thus making a seal; these tongue pieces are equipped with a small spring on the back to keep them pressed up against the inner bedded surfaces of the ring.



Gibson Springless Piston Ring

A combined coloring and hardening medium for concrete floors is a recent development of the Toch Bros., New York City. The product is put up in paste form, and in addition to possessing waterproofing qualities it is claimed to have a hardening and densifying action on the concrete. It is furnished in several colors, including terra cotta, red, brown, willow green, sea green and dark slate, special shades being made to order.

Suggested Rules for the Care of Power Boilers*

Proposed as an addition to the A. S. M. E. Boiler Construction Code

IT IS the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Boiler Code Committee.

Handling Boilers in Service

Firing

C-17. Aside from the standpoint of economy, maintain the fire as uniformly as possible in order to avoid excessive combustion, undesirable variations in temperature, and possible gas explosions. In the event of flareback or the snapping out of burners, where oil or gas is used as fuel, shut off the fuel supply and thoroughly ventilate the boiler before resuming firing.

Cleaning Fires

C-18. Clean the fires when necessary, but preferably at stated periods and when boilers are operating at low rating, as at noon time and just before peak loads. Avoid holes in fire and excessive draft while burning out the fire. Clean fires as rapidly as possible to minimize cold air in the boiler. Do not fire too heavily immediately after cleaning. Do not pile hot ashes and clinkers against the boiler front; use care in quenching and remove ashes as soon as possible.

Banking Fires

C-19. When fires are banked and the furnace temperature is reduced, make sure that enough air is carried through the furnace and boiler to prevent the accumulation of combustible gases within the setting.

Water Level

C-20. The most important rule in the safe operation of boilers is to keep water in the boiler and as constantly at the proper level as conditions will permit. Never depend entirely upon automatic alarms or feed-water regulators, no matter how effective or valuable these devices may be.

C-21. The first duty on entering a boiler room is to ascertain whether the communications and valves between the boiler and the water glasses are free and open, especially when starting up in the morning, whether the fires have been banked up over night or not, by blowing down the water columns and water glasses and noting the promptness of the return of the water to the glasses. Try the gage cocks also until sure of the water level. This should be done at the beginning of each shift and preferably before the relieved shift has gone off duty. It should also be done after replacing water glasses and more frequently when trouble is experienced with boiler compounds, foaming, priming and other feed-water troubles that are apt to cause choking of the connections.

C-22. Have the water column well lighted and keep the glass clean. Do not allow steam to leak from the water column or its connections, as this will cause the water glass to show a false water level. Keep the outlet end of the discharge pipes from the water column, water glasses, and gage cocks open and free from obstructions.

C-23. When the level of the water is not visible in the water glass, try the gage cocks to determine whether the level of the water is above or below the the water glass. If the water level is below the water glass, stop the supply of air and fuel and close the dampers and ashpit doors unless you are in touch with the entire situation as to boiler feed-water supply and positively certain that it is safer to continue steaming the boiler than to reduce the steaming rate. If found advisable not to stop the steaming rate of the boiler, determine the cause and remedy it immediately. If found advisable to stop the supply of fuel and air, do not change the feed-water supply, open the safety valves or change the steam outlet valves, or make any change that will cause a sudden change in the stresses acting on the boiler. In the case of hand-fired boilers do not disturb the fire except to cover it with green coal or wet ashes; where stokers are used, stop the fuel feed and open the firedoors. After the fire is banked or out, close the feed-water valves. When the boiler is sufficiently cooled, close the firedoors and cut the boiler off the line. Determine the cause and remedy it before the boiler is again placed in service. Also examine the boiler for overheating.

C-24. When it becomes necessary to maintain an unreasonably high feed-water pressure, examine the feed-water lines for choking due to scale or other causes.

Foaming and Priming

C-25. If any unusual or serious foaming occurs, close the steam outlet valve long enough to determine the true level of the water in the water glass. If the level of the water in the glass is sufficiently high, blow down some of the water in the boiler and feed in fresh water. Use surface blowoff if installed. Repeat the alternate blowing down and feeding several times, and if the foaming does not stop, bank the fire and continue the alternate blowing down and feeding. Test safety valve or valves and connections and connections of pressure gage, water column and water glass for any sticking or choking. Determine positively the cause of foaming and adopt measures to prevent its recurrence, as specified in Pars. C-203 to C-209.

Oil in Boiler

C-26. Watch carefully for any sign of oil in the feed-water heaters, water glasses, and blowdowns. If a boiler becomes coated with oil or grease, shut down the boiler as soon as practicable and clean it thoroughly. If the amount of oil or grease is considerable, boil out the boiler in accordance with Par. C-42.

Feed-water Treatment

C-27. Execute carefully all instructions given for the treatment of feed-water if necessary in the particular plant. It is not advisable to experiment with "home-made" treatments or boiler compounds.

Blowing Down

C-28. Except where the amount and frequency of blowing down is determined by chemical analysis, blow down at least one full opening and closing of the blowoff valve every 24 hours. Blow down the boilers at a period in the day when the steam production is lowest. When boiler is equipped with both blowoff valve and cock or quick-opening valve in the same blowoff connection, always open the cock or quick-opening valve first and the blowoff valve second. In closing, always close the blowoff valve first and the cock or quick-opening valve second. Where a large amount of blowing down is necessary, open the cock or quick-opening valve first until it is half-open and leave in that position until the water is lowered about ½ in. in the water glass. Then open wide all valves until the blowing down is completed. See that the cock or valve shuts tight and remains tight. Repair all leaky blowoff valves or cocks as soon as practicable. Use surface blowoff if installed until the undesirable conditions for which it is employed are corrected.

C-29. Where the water glass is not in view of the operator blowing down a boiler, another operator should be stationed where he can see the water glass and signal to the operator blowing down the boiler.

Leaks

C-30. When small leaks occur, locate their source and repair them as soon as the boiler can be removed from service. If a serious leak occurs such as a leak along the longitudinal seams, or near flange of drum heads, shut down the boiler immediately by gradually reducing the steam pressure and have the boiler examined by an authorized inspector.

In case of tube failure shut off air supply, keep outlet damper open, check fire and shut boiler stop valve. Maintain feed-water supply, if possible to do so, without drawing too heavily upon the supply to other boilers. Shut off

*Reprinted from *Mechanical Engineering* for May, 1925. On account of the length of the rules *Power* is printing them in short installments, of which this is the second. The rules were presented at a public hearing at the A.S.M.E. Spring Meeting in Milwaukee.

feed-water supply when brickwork has cooled sufficiently to prevent injury to boilers by overheating.

Repairs

C-31. Many casualties have resulted from the practice of repairing boilers, pipe lines and attachments under pressure; such practice should not be permitted except under the supervision of a competent and responsible person.

Removal of Soot and Ashes

C-32. Keep tubes reasonably free from soot. When a lance or soot blower is used, drain the steam or air supply connections so that the steam or air is practically dry. After the boiler has been cooled, brush or scrape away any hardened soot or deposit from the tubes.

C-33. Remove ashes frequently and do not permit the accumulation of any large amount of ashes in the ashpit, boiler flues, or base of chimney. Do not pile ashes against the boiler front and when wetting down ashes, make sure that no water is thrown on hot castings. To avoid being scalded, stand well back from hot ashes or refuse while spraying water on them. Do not leave ashes banked about blowoff pipes as a protection.

C-34. When ashes are removed by a suction system, see that the explosion door on the storage hopper is maintained free and in condition. Where steam-jet ash conveyors are used, see that all operators are warned against the water that may collect upon the top of the ashes in the hopper and which may flow suddenly from the gate when the ashes are being removed. When necessary to bar through the gate to release clogged opening, the operator should stand sufficiently aside to avoid being burned by the hot ashes or water.

HANDLING BOILERS OUT OF SERVICE

Cutting Out

C-35. Stop the supply of fuel, burn out the fuel in the furnace, and cool off the setting and boiler as slowly as is consistent with operating conditions.

After the boiler ceases to require feed water and the non-return check valve, if any, on the steam outlet has closed, close the feed-water valves and the main steam stop valve. Where both one hand-operated stop valve and one combined stop-and-check valve are used, screw down the stem of the combined stop-and-check valve to hold the valve disk on the seat. Where two stop valves are used, open the drain between the stop valves and see that it is clear. When possible, dust off tubes before fire has died out.

Emptying

C-36. Allow the setting to cool slowly, particularly where there is much sediment in the boiler. After the setting has been cooled and there is no pressure on the boiler, open the vent to prevent the formation of a vacuum and empty the boiler. When it is not practicable to empty a boiler at atmospheric pressure, blow it down at as low a pressure as is consistent with operating conditions. When the boiler to be emptied is set in a battery of two or more boilers, make sure that the blowoff valves that are opened are on the boiler that is to be emptied. As soon as the boiler is emptied, close the blowoff valves, remove the manhole plates, and, when necessary, the covers of other openings.

Cleaning

C-37. Before any person enters the drums or shell of the boiler, make sure that these parts of the boiler have been properly ventilated and that there is no inflammable gas present.

C-38. Before entering the drums or shell of a boiler, see that the blowoff valves, the main stop valve, the feed-water valves, and other valves are closed. Use some reliable method of safeguarding any one entering the shell or drum.

It is recommended that when the blowoff valves of a boiler being cleaned are connected into a common header, the blowoff valves of all other boilers be properly safeguarded against opening into the boiler being cleaned.

When electric extension cords are used when entering a boiler, the cord should not only be well insulated but designed to withstand mechanical injury and maintained in good condition. The lamps should be provided with suitable guards.

C-39. Examine the boiler to determine how often it should be washed.

C-40. Use hose with considerable force or hand tools if necessary to remove scale. Disconnect the blowoff line close to the boiler and run the water to waste, or when practical provide a screen which can be inserted in the blowoff hole. Wash the tubes of horizontal-return tubular boilers from below as well as from above.

See that the water does not come in contact with the brickwork of the combustion chamber, or if this cannot be avoided, see that the brickwork is dried out carefully when firing up.

C-41. After washing the boiler, pass a light inside and see that the cleaning has been thorough and that no tools are left inside.

C-42. Where a new boiler is to be placed into service for the first time, it may be cleaned by boiling out with a mixture of soda ash and caustic soda. Fill the boiler with water to about the middle line of the water glass and add one part by weight of soda ash and one part caustic soda at a rate of 20 lb. per 100 hp. capacity. Dissolve the chemicals thoroughly before introducing into the water. Close the boiler and start a light fire, sufficient to carry 5 lb. pressure in the boiler. Continue boiling two or three days. Empty the boiler and then wash thoroughly with fresh water.

C-43. When cleaning scale from tubes with mechanical hammer or cleaner, follow the instructions given in Par. C-270.

Laying Up

C-44. When laying up a boiler for an extended period of time, follow the instructions given in Par. C-244 to C-248.

Electrochemical Corrosion Resulting from Surface Abrasion*

It is a well-known fact that erosion frequently has a certain tendency to stimulate corrosion. One reason for this is that frequently, in the corroding of metals, a protective coating is formed and the result of abrasion or erosion is to remove this protective coating, and corrosion therefore is greatly accelerated. A result brought out in this investigation, however, is that a certain potential difference frequently exists between the surface covering of a piece of metal and the pure metal itself. Electrolysis therefore is effective in some instances, in promoting corrosion.

The experiments indicate, generally speaking, that where the corrosion product is loose and flocculent the abraded portion is often negative or cathodic, and therefore no localized corrosion need be feared. Where the corrosion product instead is a thin highly protective film, the eroded or abraded place will usually be positive or anodic, and currents set up will tend to concentrate erosion at this point.

Although electrochemical corrosion due to mechanical removal of the corrosion product is thus perfectly possible, it seems that in most cases the corrosion will occur if the abrasion is sufficient to produce also mechanical erosion of the metal. The conclusion reached, therefore, represents a compromise between the corrosionist and erosionist views.

The attack of hydrochloric acid on zinc is increased in the early stages by grinding away the natural surface with emery. In the latter stages it is decreased by wiping away the black scum of impurities which accumulates on the surface and which acts as a negative member of the corrosion couple, providing in fact a material from which hydrogen bubbles are evolved readily. Amalgamation restrains corrosion by increasing the over-potential.

A series of experiments was made to investigate the effect of the natural surfaces of sheet metals as result from operations at the mill. Natural surfaces, which may include high-temperature oxide scale, low-temperature corrosion products, grease, etc., were investigated with respect to lead, zinc, copper and steel. It appears that except in the case of steel, the danger of corrosion currents set up by removal of high-temperature oxide-scale is fairly small.

The effect of scraping the corrosion product in a salt solution was investigated. The current in all cases was small, but indicated that the scraped area was positive and therefore subject to concentrated corrosion attack. Mechanical erosion, however, exceeded the loss due to corrosion.

Although a greased surface as a whole is negative, it is by no means immune from corrosion. There is no reason, however, to fear serious localized corrosion by the removal of grease from an article covered with a grease film.

The experiments emphasize the fact that when it is desired to protect metals such as zinc or iron from corrosion by means of a grease film, it is highly important this grease be rubbed well into the crannies and crevices and not merely spread over the surface.

*Abstract of paper, "Surface Abrasion as a Potential Cause of Localized Corrosion," by Ulick R. Evans, presented at the March 11-12, 1925, meeting of the Institute of Metals, London.

Well-Type Burner for Pulverized Coal*

By H. W. BROOKS†

SEVERAL years ago it occurred to one of the engineers of the Fuller-Lehigh Co. that one of the most intense manifestations in nature of turbulent flow and agitation of gases and particles in suspension was in the tornado, where it had been repeatedly demonstrated that materials of considerable tensile strength had actually been torn apart, disintegrated and reduced to fine pieces and sometimes to powder by the centrifugal action of the air. Experiments were started at Fullerton, Pa., on a small furnace 18 in. square by 3 ft. deep in which the jets were placed to throw the flame tangent to the tornado of the fire within the furnace, the flame of the first jet being deflected before it reached the refractory walls by the impingement with equal velocity at right angles of the flame from the second jet, the third jet again changing the direction 90 deg. and the fourth jet completing the tornado within the pot. A clearer idea of the placing of these jets in the circular and the square pot burners is shown in Fig. 2.

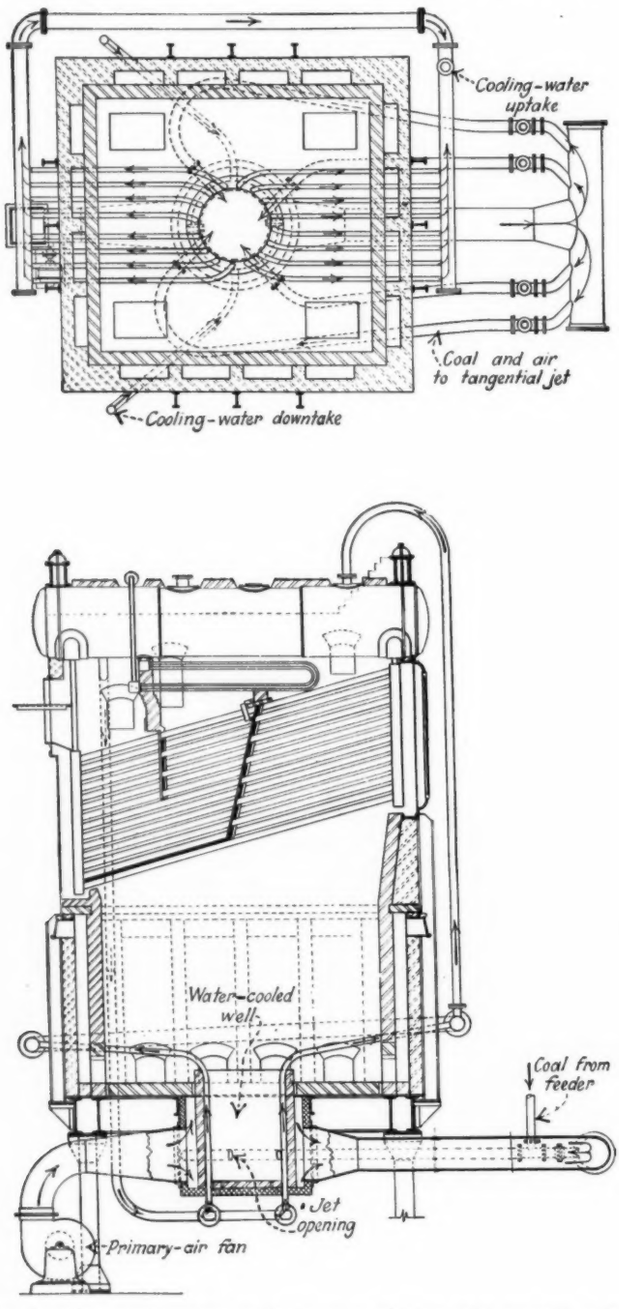


Fig. 1—Plan and section of furnace equipped with well-type burner in bottom of dispersion chamber

It was well known that the external walls of the tornado of nature had been observed to be rather sharply defined from the surrounding air. Thus it was decided to adapt this principle by placing the pulverized-fuel jets in such relation to the refractory walls that there was little, if any, impingement on the walls. As was anticipated, therefore, the refractory walls showed little damage due to erosion, and thermocouple temperatures taken on the inner refractory surface showed the inner face of the brick never exceeded 2,700 to 2,900 deg. F.

It had also long been recognized that the transmission of sensible heat from the hot gases from the furnace through the tubes of the boilers to the water on the other side was limited by the existence at the boundary surface of a "dead film," generally assumed to be about one fortieth of an inch in thickness, of relatively cool gas in which convection currents apparently did not take place, and which, owing to its low conductivity, offered a high resistance to the passage of heat (other than radiant) through it. This "dead film" is the main and most potent obstacle to rapid heat transmission in the boiler, and it follows that its complete or even partial destruction will greatly assist the flow of heat and hence the efficiency of the boiler. Tests have shown that with the higher scouring action of the swirling gases in meeting the boiler tubes there would not only be a higher rate of heat transfer and higher boiler efficiency, but also a cleansing action that would keep the tubes clear of deposited ash.

Early during the experiments the nature of the ignition and combustion taking place in the well proved quite unlike anything experienced engineers had hitherto seen in powdered-coal combustion. The flame itself resembled that of a blow torch, combustion apparently taking place in a limited zone within the well. By regulating air admission and air pressure, it was possible to move the hottest zone into the well itself or to a point just in front of the well. Appreciating further the gains due to the more efficient transfer of heat by radiant energy, the inventor had still further reason to expect efficiencies higher than had been before demonstrated in pulverized-fuel combustion, as well as a flatter over-all performance curve at high ratings.

When, finally a few of the larger operators were shown the experimental furnace at Fullerton, there were immediate volunteers who offered to install a furnace of the new type, but the results which indicated heat releases

*From discussion of a paper at the Spring Meeting of the A. S. M. E. at Milwaukee, May 18-21, 1925.

†Consulting Engineer, Fuller-Lehigh Co., Fullerton, Pa.

many times greater per cubic foot of combustion volume than had ever been before accomplished were so revolutionary in character that it was deemed best to withhold a commercial-scale installation until reasonable assurance could be had that no practical operating difficulties would be encountered.

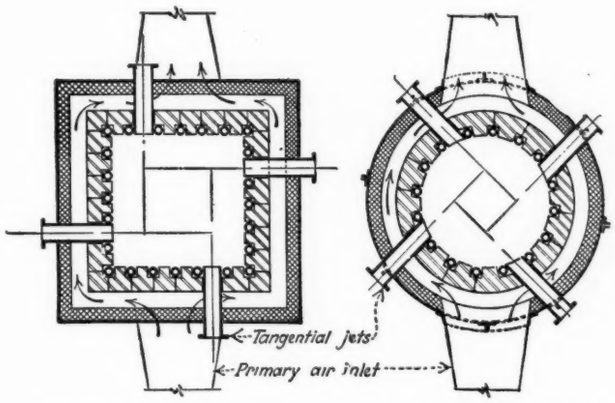


Fig. 2—Arrangement of tangential jets and water-cooling tubes in a square and round well-type burner

In February, 1924, the United Electric Light & Power Co., of New York City undertook a commercial-scale experimental installation of the new furnace to be made at its Sherman Creek Station where other types of pulverized-coal installations were being tried. By thus conducting simultaneous tests on different systems under similar conditions, the new principle would not only be subjected to a large scale test, but at the same time could be directly compared with other methods, the operating company expressing the desire to make the tests entirely with their own personnel. Today it is understood these tests have been completed, and that the efficiencies have proved from 3 to 5 per cent higher than with the other methods of firing, and the curve of efficiencies at various ratings has been much flatter than anything heretofore demonstrated.

Unfortunately, there is not available at this time a cross-section of the furnace used at Sherman Creek. In its place the section Fig. 1, is shown, indicating one of the more recent applications of the well-type burner. From the section it will be noted that above the well there is provided a dispersion chamber in which the hot gases, after burning, are allowed to expand before reaching the boiler tubes. It is not possible to state at this time the minimum size to which this chamber may eventually be reduced. It has definitely been established, however, that the combined volume of the well and dispersion chamber can be made substantially less than the combustion space provided in the ordinary stoker setting.

Simultaneous with the tests at New York, research has been continued at Fullerton on a burner consisting of an 8 ft. cube. Fig. 3 shows this burner just prior to ignition, and Fig. 4 shows it immediately after ignition. Fig. 5 shows the burner in operation burning sufficient coal to run a 15,000-sq. ft. boiler at 632 per cent of rating.

It is felt that the "well type" burner has successfully employed the principle of turbulent flow and thus made possible the efficient burning of pulverized coal in combustion volumes as small as those previously employed for stokers. This development opens possibilities in the transportation and marine field as well as in the conversion of present stoker-fired furnaces to the advantages of pulverized-coal without the necessity in many cases of more than slightly modifying the present furnace construction.

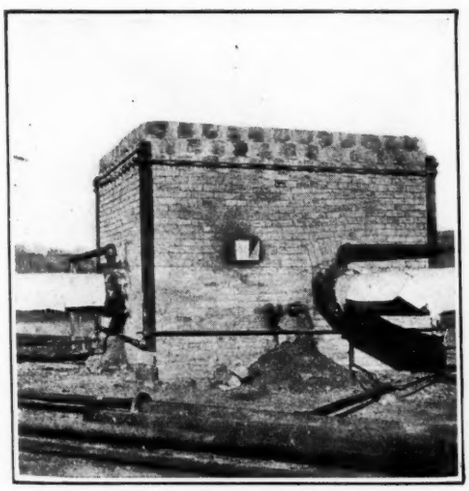


Fig. 3—Burner prior to ignition

Fig. 4—Burner just ignited

Fig. 5—Burner in operation

Large Valves for the Arapuni Project

An order has just been received by J. Blakeborough & Sons, Ltd., Brighouse, Yorkshire, a British engineering concern, to supply three Larner-Johnson valves for the Arapuni electric power scheme of the New Zealand Government. It is stated that these will be the largest valves of any type ever to be manufactured in Great Britain. Each valve will have a diameter of 12 ft. at the outlet and 9 ft. at the inlet, an over-all length of 20 ft. 3 in., and a weight of about 65 tons[1].

The valves are of the needle type and will control the flow of water to vertical turbines of the Francis type. The opening or closing time will normally be about two minutes, but can be varied to from 1½ to 3 minutes from the remote-control stations. For this purpose the makers' patent system is being used, embodying two automatic features that will come into operation in an emergency, one being designed to close the valve should there be an overspeeding of the turbine, and the other should there be a fracture of the turbine casing causing an abnormal velocity through the valve. The valves will be controlled from the main switchboard, from the generator-room floor, or by hand or electric indicators on the main switchboard and in the generator room.

If a series armature winding has an open-circuit, a burnt spot will occur on the commutator for each pair of poles. If a coil is open-circuited in a 4-pole series winding, then two burnt spots 180 deg. apart will occur on the commutator, and in a 6-pole machine three burned spots 120 deg. apart will develop.

[1]The Larner-Johnson valves at Niagara are much larger than these, being 21 ft. at the inlet and 14 ft. at the discharge with a maximum diameter of 24 ft. 4½ in. They weigh 307 tons each.

Muscle Shoals Power Will Probably Not Be Utilized Before Testing of Generators

Tests Not Expected to Be Completed Before January First—William Green Advocates Retaining Shoals for Government Experimentation and Standards

THE PRESIDENT'S Muscle Shoals Commission will meet in Washington on June 10 to discuss and possibly take action on the letter of the Secretary of War concerning the disposition of power at the Shoals prior to congressional action to that end.

The Secretary of War wrote the Commission on April 14 about this matter and requested an early reply. The delay has been occasioned, it is understood, by the belief of a majority of the Commission that no commercial use should be made of any of the power generated prior to its permanent disposition by Congress.

Apparently, power at Muscle Shoals will be available so sporadically during the testing period, which will extend from August to late next spring, that no formal contract will be entered into for such power as may be for sale.

The electrical contractors have advised the Chief of Engineers, who has charge of the construction of the plant, that the tests of the four generators should be conducted under load.

It may require until Dec. 1, or even the first of the year, General Taylor says, to complete the testing of these four generators. It is expected that the switchboard will then be ready for test, after which the four other generators are expected to be ready for testing.

General Taylor believes that it would interfere unduly with the completion of the project to be under any commitments or even under implied obligations to give advance notice as to the cutting off of power. He favors an arrangement whereby the tests can be made under the actual load that would be furnished through connection with the lines of the local power system.

President Green Advocates Government Operation

The desirability and advantage of development and operation of Muscle Shoals by the government was emphasized by William Green, president of the American Federation of Labor, in a letter he wrote today to representative John C. McKenzie, chairman of the Muscle Shoals Inquiry Commission, who had asked his opinion as to the best disposition of the Shoals.

"Since such large government funds have already been expended," Mr. Green wrote. "it would. in my mind, be a highly desirable and advantageous experience to continue Muscle Shoals as a government undertaking and experimental development to set standards for private undertakings and records of costs."

A public policy to retain ownership for the people and the establishment of a system of control of all hydro-electric and water-power undertakings where conditions and terms of operation and development may be determined were advocated by Mr. Green. Where leases were granted, he said, they should be for a specific period only, with fifty years as a maximum.

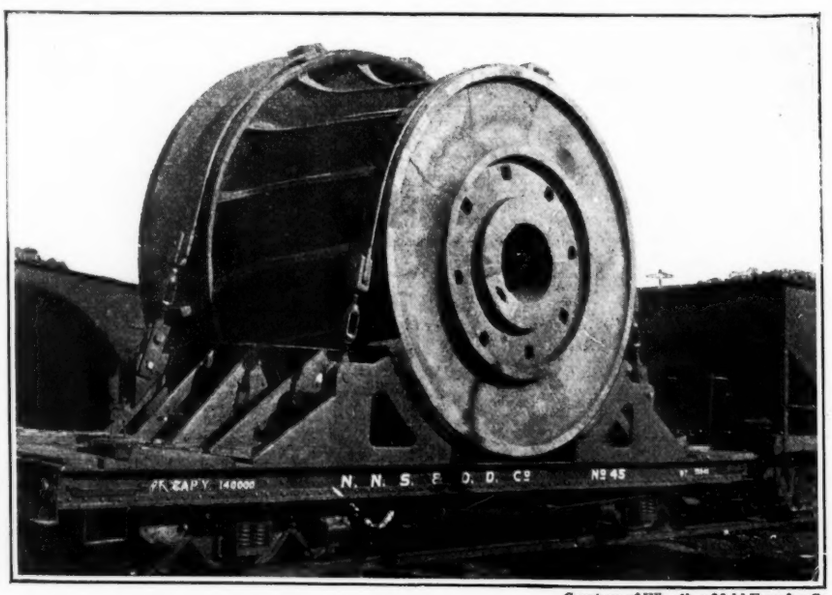
Similar statements from James P. Noonan, president of the International Brotherhood of Electrical Workers, and Arthur M. Huddell, president of the International Union of Steam and Operating Engineers, were presented.

A resolution adopted by the American Federation of Labor in 1923 was included in the documents submitted to the commission. It opposed the subsidizing of private corporations for the purpose of establishing a privately owned and operated power system, and favored the public development and control of all water resources for the service of the people at cost.

Chicago Sanitary District Asks a Rehearing

Stating that several of the issues had been construed erroneously by the Court in arriving at its previous decision, a petition for rehearing of the case granting an injunction to the government was filed in the United States Supreme Court June 1, by attorneys representing the Sanitary District of Chicago in the Lake Michigan diversion case.

Among points raised in the brief supporting the petition for rehearing is one that the Court erroneously construed the Canadian boundaries water treaty in which the Sanitary District contends the report of the commissioners conceded that 10,000 cu.ft.-sec. of water was allowed to be diverted at Chicago. It also is contended that the permits for opening the drainage canal and improvement of the Chicago River were irrevocable; that the limitation upon diversion of water from the lake was designed to prevent interference with navigation in the Chicago River and that the river had been improved and straightened at a cost of some $14,000,000, thus removing the original cause of the limitation. The Court, in sustaining the injunction, erroneously construed the permits, it is argued. It also is contended that the government has sought relief exclusively under the River and Harbor Act of March 3, 1899, but that the Court had not confined its decision to construction of that law but had applied other principles, thus having gone outside the case.



Courtesy of Wheeling Mold Foundry Co.

Casting for 35,000 *hp. runner is* 15 *ft.* 4 *in. diameter,* 9 *ft.* 5 *in. high, and weighs* 130,000 *lb. Four of these and four* 30,000 *hp. units are being placed in the initial installation at Muscle Shoals*

Canadian Regulations To Be Enforced

The regulations governing the sale of electrical equipment are to be strictly enforced in Canada hereafter, Trade Commissioner L. W. Meekins advises the Department of Commerce. A number assigned by the Hydro-Electric Power Commission should appear on all approved products offered for sale in the Province of Ontario. Failure to do this may result in prosecution of the dealer and the exclusion of the manufacturer from the market.

Holyoke, Mass., Reduces Rates On Electricity

The City of Holyoke, Mass., gas and electric light department, has announced a material cut in the price of electricity furnished for lighting and power purposes. The new rates range from, for the first 200 kw.-hr. per month at 4.10 cents per kw.-hr. up to 200,000 kw.-hr. per month at 1.50 cents per kw.-hr. Discounts will be allowed for prompt payment of bills and the maintenance of designated power factor. With the discounts allowed the net price of electricity for power purposes when over 200,000 kw.-hr. are used in any month will be 10 mills a kilowatt-hour.

British Experimenting with Liquid Coal

By heating powdered coal to high temperatures and pressures in an atmosphere of hydrogen, liquid fuel can be obtained, according to an item in *The Engineer*. Up to the present several different types of English coals have been investigated, and Professor Nash, of Birmingham University, states the results are encouraging. A South Staffordshire coal, on hydrogenation, gave 37 per cent of liquid, a South Wales coal 26 per cent, and a Lancashire coal 61 per cent. These figures give respectively 80, 56 and 130 gal. liquid per ton of dry ashless coal.

Big Merger of N. Y. State Utilities Announced

A petition has been filed with the Public Service Commission of New York State, by the Mohawk-Hudson Power Corp., a holding company, for consent to acquire and hold the stock of the Municipal Gas Co., of Albany, Cohoes Power & Light Corp., Utica Gas & Electric Co., Adirondack Power & Light Corp. and the Fulton Gas & Electric Co., five of the large electric light and power companies in the Mohawk and upper Hudson Valleys.

The petition states that the purpose of the consolidation is to centralize the general policy of the various companies into one corporate body leaving, however, the local corporations as separate operating entities. It is claimed that a co-ordination operation will obtain maximum economy in the production and distribution of electric energy, by utilizing water that has heretofore been running to waste, exchanging facilities, eliminating the transmission of power by two companies in opposite directions past each other with resultant excessive loss, building additional facilities either steam or hydro when needed.

Trade Association Statistical Activities Clarified by Supreme Court Decision

Majority Decision Reverses Decrees of Lower Courts on Prosecutions Under Sherman Anti-Trust Law

A SWEEPING decision, clarifying the legal view of trade association activities in gathering and distributing statistics, was handed down by the United States Supreme Court June 1, when decrees of lower courts enjoining the Maple Flooring Manufacturers Association and the Cement Manufacturers Protective Association under the Sherman Anti-trust law were reversed.

After reciting the history of the case, the majority opinion in the flooring manufacturers association case lays down broad principles:

"It is not, we think, open to question that the dissemination of pertinent information concerning any trade or business tends to stabilize that trade or business and to produce uniformity of price and trade practice. Exchange of price quotations of market commodities tends to produce uniformity of prices in the markets of the world. Knowledge of the supplies of available merchandise tends to prevent overproduction and to avoid the economic disturbances produced by business crises resulting from overproduction. But the natural effect of the acquisition of wider and more scientific knowledge of business conditions on the minds of the individuals engaged in commerce and its consequent effect in stabilizing production and price can hardly be deemed a restraint of commerce or, if so, it cannot, we think, be said to be an unreasonable restraint or in any respect unlawful.

"It is the consensus of opinion of economists and of many of the most important agencies of government that the public interest is served by the gathering and dissemination, in the widest possible manner, of information with respect to the production and distribution, cost and prices of actual sales, of market commodities because the making available of such information tends to stabilize trade and industry, to produce fairer price levels and to avoid the waste which inevitably attends the unintelligent conduct of economic enterprise. Free competition means a free and open market among both buyers and sellers for the sale and distribution of commodities. Competition does not become less free merely because the conduct of commercial operations becomes more intelligent through the free distribution of knowledge of all the essential factors entering into the commercial transaction. General knowledge that there is an accumulation of surplus of any market commodity would undoubtedly tend to diminish production, but the dissemination of that information cannot in itself be said to be restraint upon commerce in any legal sense. The manufacturer is free to produce, but prudence and business foresight based on that knowledge influences free choice in favor of more limited production. Restraint upon free competition begins when improper use is made of that information through and concerted action which operates to restrain the freedom of action of those who buy and sell.

"It was not the purpose or the intent of the Sherman anti-trust law to inhibit the intelligent conduct of business operations, nor do we conceive that its purpose was to suppress such influences as might effect the operations of interstate commerce through the application to them of the individual intelligence of those engaged in commerce, enlightened by accurate information as to the essential elements of the economics of a trade or business, however gathered or disseminated. Persons who unite in gathering and disseminating information in trade journals and statistical reports on industry; who gather and publish statistics as to the amount of production of commodities in interstate commerce and who report market prices are not engaged in unlawful conspiracies in restraint of trade merely because the ultimate result of their efforts may be to stabilize prices or limit production through a better understanding of economic laws and a more general ability to conform to them, for the simple reason that the Sherman law neither repeals economic laws nor prohibits the gathering and dissemination of information. Sellers of any commodity who guide the daily conduct of their business on the basis of market reports would hardly be deemed to be conspirators engaged in restraint of interstate commerce. They would not be any the more so merely because shareholders in a corporation or joint owners of a trade journal, engaged in the business of compiling and publishing such reports.

"Viewed in this light, can it be said in the present case, that the character of the information gathered by the defendants, or the use which is being made of it, leads to any necessary inference that the defendants either have made or will make any different or other use of it than would normally be made if like statistics were published in a trade journal or were published by the Department of Commerce, to which all the gathered statistics are made available? The cost of production, prompt information as to the cost of transportation, are legitimate subjects of inquiry and knowledge in any industry. So likewise is the production of the commodity in that industry, the aggregate surplus stock, and the prices at which the commodity has actually been sold in the usual course of business.

"We realize that such information gathered and disseminated among the members of a trade or business may be the basis of agreement or concerted action to lessen production arbitrarily or to raise prices beyond the levels of production and price which would prevail if no such agreement or concerted action ensued and those engaged in commerce were left free to base indi-

vidual initiative on full information of the essential elements of their business. Such concerted action constitutes a restraint of commerce and is illegal and may be enjoined, as may any other combination or activity necessarily resulting in such concerted action, as was the subject of consideration in American Column & Lumber Co. v. United States supra and United States v. American Linseed Oil Co. supra. But in the absence of proof of such agreement or concerted action having been actually reached or actually attempted, under the present plan of operation of defendants, we can find no basis in the gathering and dissemination of such information by them or in their activities under their present organization for the inference that such concerted action will necessarily result within the rule laid down in those cases.

"We decide only that trade associations or combinations of persons or corporations which openly and fairly gather and disseminate information as to the cost of their product, the volume of production, the actual price which the product has brought in past transactions, stocks of merchandise on hand, approximate cost of transportation from the principal point of shipment to the points of consumption, as did these defendants, and who, as they did, meet and discuss such information and statistics without, however, reaching or attempting to reach any agreement or any concerted action with respect to prices or production or restraining competition, do not thereby engage in unlawful restraint of commerce."

Colorado Fuel & Iron Co. To Build New Power Plant

The decision to electrify was reached about a year ago, when the Colorado Fuel & Iron Co. executives decided that electricity would prove more economical and efficient for the operation of its Minnequa Works, Pueblo, Colo. The mills are, at present, engine-driven, using low-pressure steam obtained from a hand-fired boiler plant. This plant will be superseded by a complete new power house, using powdered fuel and waste gas fired boilers which will provide steam at 300 lb. pressure and 180 deg. F. superheat. Complete electrical equipment will be furnished by the General Electric Company.

Hydro Plant for Stanislaus River, Calif.

Under a co-operative agreement with the Oakdale and South San Joaquin Irrigation Districts, the Pacific Gas & Electric Co. will build a 30,000-kw. hydro-electric plant to cost $1,500,000, on the Stanislaus River near Melones, Calif. On May 18 the two irrigation districts approved a bond issue of $2,200,000 for building a dam and reservoir, and the power company will build the power plant.

A 210-ft. dam of 112,000 acre-ft. capacity is to be built with the power house a mile down the river, which will be connected with the dam by a tunnel so built as to take the greatest possible advantage of the head available. The date for completion of the power plant has not been set.

New Mining Machine May Cut Cost of Coal

At the American Mining Congress, Edward J. O'Toole, general superintendent of mines of the United States Coal & Coke Co., stated that by an invention which he had made and which was in use in his company the cost of mining coal would be reduced 50 per cent. The machine is a combined cutter and loader. He said: "This machine makes the use of explosives in the mine unnecessary and will reduce accidents. It undercuts the coal by chewing into it with steel teeth. Then the coal automatically falls down upon a self-loader.

Severe Lightning Flash Has Energy of 4-Kw.

The electric energy now produced at Niagara Falls is less than that produced by nature in the thunderstorms always in progress throughout the world, said F. W. Peek, Jr., consulting engineer of the Pittsfield Works of the General Electric Co., in speaking before a joint meeting of the Detroit and Ann Arbor sections of the A.I.E.E. at Ann Arbor on May 26. The talk "Lightning and Other High-Voltage Phenomena," described the interesting work being done in the Pittsfield laboratory with artificial lightning generators.

Statistics show that at any instant there is an average of 1,800 thunder storms in progress in the world, giving 300,000 lightning flashes per hour, said Mr. Peek. Investigations with laboratory lightning show that the energy of a severe lightning flash is about 4 kw.-hr. The total energy represented by 300,000 severe flashes would, therefore, be 1,200,000 kw.-hr., or more than 1,500,000 hp. operating continuously to supply the world with severe lightning.

Federal Arbitration Act Effective Jan. 1, 1926

In connection with the call of a delegation of business men on President Coolidge to express thanks for his part in the enactment of the new Federal Arbitration Act, a statement was given out by a spokesman for the Arbitration Foundation explaining the act and its application:

"The wide public interest in commercial arbitration at this time grows out of the fact that the new federal act goes into effect next Jan. 1, and after that date business contracts may contain an arbitration clause which binds the parties to submit differences to an arbitrator of their own or the court's selection. Federal courts are given authority to enforce the arbitration agreement, by requiring submission of the dispute to arbitrators and by entering a judgment based on the award. The law provides safeguards permitting courts to review, modify or revoke the award under certain conditions.

"Chambers of commerce and trade associations are now studying the law as a preliminary to the organization of arbitration bureaus and are advising their members on the forms of clauses under which many of their disputes may be settled outside of court. In this work they will be assisted by the Arbitration Foundation, which has headquarters at 65 Liberty St., New York City."

New York and New Jersey now have such laws in operation, and Massachusetts and Oregon have adopted laws during the last few months. Other states are expected to adopt uniform state arbitration laws, applicable to intrastate business transactions, to supplement the federal law which covers only interstate and maritime transactions.

Disposal of Hetch Hetchy Power Again Uncertain

Failure of the citizens' advisory committee and officials of the Pacific Gas & Electric Co. to reach an agreement has thrown the entire matter of the temporary disposal of San Francisco's Hetch Hetchy power open again after it was thought the matter was nearing settlement. The Pacific Gas & Electric Co. offered the city $2,000,000 a year for the 420,000,000 kw.-hr. of energy from the Moccasin power plant, to be paid in equal monthly installments.

The advisory committee proposed a plan by which the power might be distributed over the private corporation's lines to consumers, to be charged for at existing legal rates, all bills to be collected and accounted for by the power company for a stipulated compensation or a fixed price per unit of power handled, said compensation to be determined by the State Railroad Commission.

Personal Mention

Dean Howard McClenahan of Princeton University has resigned from the faculty to become secretary of the Franklin Institute at Philadelphia.

O. C. Merrill, executive secretary of the Federal Power Commission, will receive the honorary degree of Doctor of Science from Bates College on June 22.

H. Foster Bain, since 1921 head of the United States Bureau of Mines, has been selected as secretary of the American Institute of Mining and Metallurgical Engineers.

Senator George W. Norris, of Nebraska, who has been interested in the disposition of Muscle Shoals, is reported to be visiting the hydro-electric system of Ontario as the guest of Sir Adam Beck.

R. M. Coleman, who for many years has been manager of the electrical department of Fairbanks, Morse & Co., New York, has opened offices of his own under the name of R. M. Coleman Co. at Long Island City.

Thomas E. Purcell, formerly mechanical engineer, with Dwight P. Robinson, Inc., consulting engineers and constructors, New York City, is now general superintendent of power stations for the Duquesne Light Co., Pittsburgh, Pa.

Kenneth B. Aldrich, formerly electrical engineer for the Puget Sound Power & Light Co., Tacoma, Wash., has opened consulting engineering offices with B. W. Kibler, dean of the trade engineering department, City College, Tacoma, Washington.

Samuel Insull, of Chicago, has been elected president for the coming year of the National Museum of Engineering and Industry by its board of directors.

W. C. Lancaster, consulting engineer, has been appointed chief engineer of the Transit Commission of the State of New York to succeed the late John H. Madden. He is a member of the A. S. M. E., A. I. E. E. and other engineering organizations.

Richard L. Hearn, assistant chief engineer of the Washington Water Power Co., Spokane, Wash., has resigned his position to enter partnership with H. G. Acres, formerly chief engineer for the Hydro-electric Power Commission, Canada, who now has a consulting engineer practice in Niagara Falls, Ontario.

Herbert E. Collins, well known to *Power* readers of a few years back, and more lately engaged in consulting practice in Utica, N. Y., has become associated as consulting engineer with the Anthracite Coal Service in central New York. In this capacity he will devote much of his time to advising with industrial executives on the proper use of anthracite in their power plants.

Tse Tsok-Kai, general manager of an electric light and power company in Canton, China, is visiting in this country and is inspecting power developments throughout the United States before attending the National Foreign Trade Convention which is to be held in Seattle June 24-26. Mr. Tse stated that conditions are not chaotic in Canton and that the street lights have never failed because of revolutionary activities. He expressed optimism over China's future.

Business Notes

The Centrifix Corp., Cleveland, Ohio, manufacturer of equipment for cleaning fluids, announces the appointment of the Riley-Fredericks Co., Security Bldg., Milwaukee, Wis., as its district sales engineers.

Warren Webster & Co., 17th and Federal Sts., Camden, N. J., is opening a new branch office at 327 Washington Ave., Scranton, Pa., which will operate under the Wilkes-Barre office and be under the management of C. S. Dean.

The Riley Stoker Corp., Worcester, Mass., announces that negotiations have just been completed by the Riley Stoker Co., Ltd., London, whereby Riley, Jones, Murphy and Harrington stokers will be made and sold in Germany by the Deutsche Evaporator - Aktiengesellschaft, of Berlin. The firm's products and service are now available in practically all parts of the world through the following associated companies, licensees and agents: Canada, Riley Engineering & Supply Co., Ltd., Toronto; British Empire, except Canada and Australia, Riley Stoker Co., Ltd., London; France, Holland, Belgium, Italy, Switzerland, Jugoslavia and the colonies, Fama, Paris; Germany and Poland, Deutsche Evaporator-Aktiengesellschaft, Berlin; Japan, American Trading Co.; China, Andersen-Meyer & Co.; Australia, Fyvie & Stewart, Melbourne.

Coming Conventions

American Association for the Advancement of Science, Burton E. Livingston, Smithsonian Bldg., Washington, D. C. Eightieth annual meeting at Portland, Ore., June 17-20.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at Saratoga Springs, June 22-26. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Order of Steam Engineers. W. S. Wetzler, 753 N. 44th St., Philadelphia, Pa. Annual convention at Moose Hall, 1314 N. Broad St., Philadelphia, Pa., June 8-12.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, Chalfonte-Haddon Hall, June 22-26.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Summer meeting at Salt Lake City, Utah, July 8-10.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Traymore Hotel, Atlantic City, June 15-17.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Portland, Ore., June 22-25.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Canadian Association of Stationary Engineers. G. A. Brown, Major St., Toronto, Ont. Convention at Windsor, June 22-25.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **New York Association** at McAlpin Hotel, New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 9-11, formerly announced July 10-12. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association** at Muskegon, July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Smoke Prevention Association—Frank A. Chambers, 1411 City Hall Sq. Bldg., Chicago, Ill. Nineteenth annual convention at Hotel Pantlind, Grand Rapids, Mich., June 17-20.

Society of Automotive Engineers, Inc. C. F. Clarkson, 29 West 39th St., New York City. Convention at Greenbrier Hotel, White Sulphur Springs, June 15-19.

Society for the Promotion of Engineering Education. F. L. Bishop, University of Pittsburgh, Pa. Meeting at Union College, Schenectady, N. Y., June 17-20.

Trade Catalogs

Filter—The Famous Filter Co., 116 Pine St., St. Louis, Mo. Leaflet describing the oil filter manufactured by the company.

Blowers & Fans — The American Blower Co., Detroit, Mich. Data sheets with prices and Bulletin No. 1 "How to Get Restaurant Ventilating Business," describes the use of these fans and blowers for this particular application.

Diesel Engines—Fulton Iron Works Co., St. Louis, Mo. Bulletin 808, "The Type J Fulton-Diesel," which is fully illustrated, gives details regarding engine sizes and also gives a diagram of the engine with tables of principal dimensions.

Stokers—The M. A. Hoff Co., Indianapolis, Ind. Catalog, "Stop Fuel Waste by Installing the National Stoker," has just been issued by this company. It describes and illustrates with drawings and photos the advantages of this stoker.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	June 1, 1925
Pool 1	New York	$2.40@$2.70
Smokeless	Boston	1.54
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.80@ 2.15
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.40@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.15@ 1.50
S. E. Ky.	Louisville	1.15@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.50
Buckwheat No. 1.	Philadelphia	2.25@ 2.75
Birdseye	New York	1.60@ 1.85

FUEL OIL

New York—June 4, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b., Bayonne, N. J.

St. Louis—May 26, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.70 per bbl.; 26@28 deg., $1.75 per bbl.; 28@30 deg., $1.80 per bbl.; 30@32 deg., $1.85 per bbl.; 32@36 deg., gas oil, 4.7c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh—May 27, f.o.b. local refinery; 30@34 deg. fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—May 23, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia—May 29, 28@30 deg., $2.21@$2.273 per bbl.; 18@22 deg., $1.974@$2.037; 13@16 deg., $1.68@ $1.743 per bbl.

Boston—June 1, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4½c. per gal. light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — June 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

New Plant Construction

Ark., El Dorado—Home Ice Co. awarded general contract for a 25 ton capacity ice plant to York Products Co., St. Louis, Mo. Machinery to cost $25,000 will be installed.

Calif., Beverly Hills—Beverly Globe Ice Co., Los Angeles, awarded contract for the construction of an ice cream factory including ice plant, cooling tower, loading platform, etc., at 1030 Santa Monica Blvd., here, to Kimmerle-Hess Co., 230 West Jefferson St., Los Angeles. Estimated cost $100,000.

Calif., Oakland — East Bay Municipal Utility Dist., Ray Bldg., 1924 Broadway is receiving bids until July 20th for the construction of 350 ft. dam, to impound the waters of the Mokelumne River, near Lancha Plana; pumping plant, with auxiliaries, aqueduct, etc. J. H. Kimball is secretary.

Fla., Deland—Bd. of Bond Trustees, City Hall, will receive bids until July 1st for improvements to waterworks and sewer systems, including sewage pumping station, deep well pumps, pump house, tank on tower, etc. J. B. McCrary Engineering Corporation, Citizens & Southern Bank Bldg., Atlanta, Ga., is engineer.

Ill., Chicago—South Park Comrs, E. J. Whitty, Secy., 57th St. and Cottage Grove Ave., will receive bids July 1st for the construction of additions to stadium including heating and ventilating, coal and ash handling machinery, etc., on Lake Front between Roosevelt Road and 16th St. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Joliet—E. Brielmaier & Sons, 432 Broadway, Milwaukee, Wis., Archts., will receive bids about June 10th for the construction of a 3 story orphanage including boiler house, etc., here, for Guardian Angel Orphanage. Estimated cost $400,000.

Ill., Marengo—City, C. H. Woleben, Clk., will receive bids until June 25th for additions to waterworks system including 450 g.p.m. centrifugal pump with motor, gasoline engine, etc. Randolph-Perkins Co., 1210 First National Bank Bldg., Chicago, is engineer.

Ia., Sioux City—Illinois Central R.R., 135 East 11th Place, Chicago, Ill., awarded contract for foundations for round house pump house, etc., for terminal, here, to Coomer & Small, 311 United Bank Bldg., Sioux City. Taking bids on superstructures. Total estimated cost $599,500.

La., Shreveport — Southwestern Gas & Electric Co. awarded contract for the superstructure of a power plant to Glassell-Wilson Co., Shreveport. Estimated cost $300,000. E. F. Neild, Merchant Bldg., is engineer. Equipment to cost approximately $150,000 will be installed.

Mass., Amherst—Amherst College, G. D. Olds, Pres., awarded contract for the construction of a power house to Lewell Whipple Co., 44 Portland St., Worcester.

Mass., Boston—The Knickerbocker Ice Co., C. E. Small, 41 East 42nd St., New York, is having preliminary plans prepared for the construction of a plant, here. Private plans.

Mass., South Boston (Boston P. O.)—C. M. Woodman, 20 Grimes St., is in the market for 130 ft. per minute capacity gasoline driven air compressor.

Minn., Minneapolis — City Purchasing Dept., F. S. Gram, Purch. Agt., will receive bids until June 10, for equipment for the Fridley Pumping Plant, including 3 single stage, low service, centrifugal pumps, 20,000,000 g.p.d. capacity, against a 43 to 45 ft. head; 3 single stage, high service, centrifugal pumps, 20,000,000 g.p.d. against a 225 ft. head; electric motors with starting equipment; operating tables for each of 10 filters, etc.

Mo., Cape Girardeau—Miles Packing Co., A. E. Miles, Pres., has had plans prepared for the construction of a canning and packing plant including refrigerating system. Estimated cost $80,000. Private plans.

Mo., St. Louis—C. Woolley, 617 Arcade Bldg., 8th and Olive Sts., is in the market for a 60 ft. capacity, air compressor, 18 to 20 hp. steam engine.

Mo., Republic—City is having preliminary plans prepared for the construction of a waterworks system including pumping equipment, tank on tower, etc. Estimated cost $40,000. W. S. Merkle, 414 North 12th St., St. Louis, is engineer.

Neb., Norfolk—City has retained A. L. Mullergren, Consult. Engr., Gates Bldg., Kansas City, Mo., to make complete report and estimates for municipal electric light plant; petitions have been filed with the city to call an election to vote $250,000 bonds.

N. J., Highland Park—Mayor and Borough Council, J. F. Flagg, Clk., will receive bids unil June 15th, for the construction of sanitary sewers including pumping station. P. Wilson, 46 Patterson St., New Brunswick, is engineer.

N. Y., Flushing—Knickerbocker Ice Co., 45 East 42nd St., New York, is having plans prepared for addition to ice plant on Collins Place. Estimated cost $150,000. Private plans.

N. Y., New York—Bellevue & Allied Hospital, J. J. McGrath, Pres., 26th and 1st Ave., plans the construction of a hospital including steam heating system at Jackson Ave. between 145th and 147th Sts. Estimated cost $1,200,000. Private plans.

N. Y., New York—Dept. of Public Markets, E. J. O'Malley, Comr., Municipal Bldg., will receive bids until June 16th for complete electrical and refrigerating equipment for power house and wholesale market for Bronx Municipal Terminal Market at Exterior and East 151st St.

N. Y., New York—M. Ehrlich Corporation, 1 Pershing Sq., is having preliminary plans prepared for the construction of a 35 story office building at Park Ave. between 32nd and 33rd Sts. Estimated cost $7,000,000. V. C. Farrar, 1 Pershing Sq., is engineer.

N. Y., New York—L. E. Kleban Inc., 1714 Crotona Park East, plans the construction of a 15 story apartment at 207 West 106th St. Estimated cost $1,500,000. Owner will build by separate contracts.

N. Y., New York—Level Club Inc., 922 St. Nicholas Ave., awarded contract for the construction of a 14 story club and hotel at 251 West 73rd St. to J. Stewart & Co., Inc., 17 East 42nd St. Estimated cost $1,000,000. Steam heating system will be installed.

N. Y., New York—Rosenzeig Bros., c/o Shwartz & Gross, 347 5th Ave., Archts. and Engrs., is having plans prepared for the construction of a 16 story hotel at 137 West 49th St. Estimated cost $2,000,000.

N. Y., New York—Sloan & Robertson, 1 Pershing Sq., Archts., will receive bids until June 15th for the construction of a 21 story office building at Cedar and William Sts., for Cedar William St. Corporation. Estimated cost $2,500,000.

N. C., Saluda—The Blue Ridge Power Co., Spartanburg, S. C., awarded contract for the construction of a dam, tunnels, power house substructure, etc. for hydro-electric development near here, to Rinehart & Dennis Co., Inc., Charlottesville, Va. Estimated cost $2,000,000.

O., Cleveland—Motors Realty Co., G. G. Peckham, Pres., 1903 East 19th St., c/o W. S. Ferguson Co., 1900 Euclid Ave., Archt., will receive bids until June 15th for the construction of a 10 story office and commercial building at Euclid Ave. and East 24th St. Estimated cost $1,000,000.

O., Cleveland—Mt. Sinai Hospital, 1800 East 105th St., will receive bids until June 15th for the construction of a group of buildings including boiler house, etc. Private plans.

Okla., Davenport—City plans an election to vote $33,000 bonds for the construction of a waterworks system including a deep well pump and motor. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Garber—City, L. C. McGill, Supt., is in the market for a new 200 g.p.m. 25 hp. motor driven centrifugal pump.

Okla., Guthrie — City is having preliminary plans prepared for the installation of a 200 hp. Diesel oil engine generator unit for waterworks plant. Estimated cost $30,000. W. I. Mathis, 411 East Oklahoma St., is engineer.

Okla., Okemah—City plans an election June 15th to vote $200,000 bonds for the construction of a water plant, pumping station, etc. including motor driven centrifugal pumps. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Purcell—City is having preliminary plans prepared for the construction of a 500,000 gal reservoir, well, triplex pump, etc. Estimated cost $15,000. G. F. Jones, is engineer.

Pa., Braddock—United Electric Light Co., Wilmerding, plans the construction of a new central station on Monongahela River. Day & Zimmermann Inc., 1600 Walnut St., Philadelphia, are engineers.

S. C., Parris Island — Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until June 22nd for 625 kva. turbo-alternator, with exciter, surface condenser, one turbine and one motor driven centrifugal circulating pump, turbine driven centrifugal condenser pump, etc., at Marine Barracks, here.

Tenn., Chattanooga—Davenport Hosiery Mills, 906 Georgia Ave., has awarded contract for design and construction of a 2 story, 93 x 228 ft. hosiery plant including 22 x 28 ft. boiler room to Lockwood, Greene & Co., Healey Bldg., Atlanta, Ga.

Tex., Bastrop — Texas Public Utilities Co., Waco, has purchased the interests of Bastrop Water Light & Ice Co., here, and is having preliminary plans prepared for the construction of a central power station. Estimated cost $250,000. Company engineers in charge.

Tex., Laredo—Mission Ice Co., 226 Rivas St., San Antonio, will build an addition to ice plant here, to increase capacity 20 ton. Equipment will be required. L. Harrington & Co., Houston Bldg., San Antonio, are engineers.

Tex., Naples—City plans an election soon to vote $45,000 bonds for the construction of a waterworks system including pumping machinery, etc. E. L. Dalton, 319 Wilson Bldg., Dallas, is engineer.

Tex., Panhandle — City, C. E. Deahl, Mayor, plans improvements to power plant including additional power equipment, distributing system, etc. Estimated cost $35,000.

Tex., San Antonio—L. J. Hart, Gunter Bldg., E. J. Altgelt, Frost National Bank Bldg., A. Seeligson, 115 East Ashby St. et al., plan the construction of an 8 story apartment including heating and cooling systems and two elevators at Lexington and Oakland Sts. Estimated cost $1,000,000. Kelwood Co., Travis Bldg., is architect and engineer.

Tex., Vernon — City, c/o H. Mason, Mayor, will soon take new bids for sinking of a well to develop not less than 1,000,000 g.p.d., also pumps to deliver into elevated tanks or surface reservoir. Former bids rejected. Estimated cost $30,000. Engineer not announced.

Wis., Friendship—Friendship Power Co., G. Poliska, Mgr., is receiving bids for structural steel, tainter gates, etc., for power plant. Private plans.

Wis., Janesville — Mead & Seastone, Journal Bldg., Madison, Engrs., are receiving bids for one new vertical unit consisting of 240 hp. turbine direct connected to one 200 k.v.a. generator, governor, etc., for Wisconsin Power & Light Co., Gay Bldg., Madison, plant here.

Wis., Jefferson—Jefferson Co., O. F. Roessler, Chmn. of Building Comm., plans the construction of a 2 story power house for insane asylum. Estimated cost $25,000.

Ont., Garneau Junction—Quebec Artificial Coal Co., Ltd., is in the market for complete equipment for power house.

Wis., Mason — W. N. Albertson & Co., 415 East Water St., Milwaukee, is having preliminary plans prepared for the construction of a hydro-electric plant on White River here. Private plans.

Wis., Pestigo—Mead & Seastone, Journal Bldg., Madison, is receiving bids for four 6 x 20 taintor gates, turbine and generator for hydro electric plant here for Wisconsin Public Service Co., 559 Marshall St., Milwaukee.

Wis., Stoughton—Martin Luther Home, N. A. Stubkjaer, Supt., is having plans prepared for the construction of a 2 story heating plant. Estimated cost $55,000. Law & Law, 1st Central Bldg., Madison, are engineers.

Ont., Grimsby — City Council plans to equip hydro electric lighting power and distribution system. Estimated cost $50,000. Ontario Hydro Commission, Toronto, are engineers.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Recent development of firmness in several of the major non-ferrous metals is reflected in slightly higher quotations for power plant supplies made from these materials. In other directions, however, there is price weakness, particularly in such items as: armored cable, flexible cord, fuses, rubber-covered copper wire, sockets and linseed oil.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket	56c. per ft.
Common, 2½-in., cotton-rubber lined ..... 80c. per ft. list less	45%

Air—Best grade

¾-in., per ft.	3-ply....$0 33	4 ply....$0.40

Steam—Discounts from List

First grade.....40% Second grade.....40-5% Third grade..40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade.....50-5% Second grade.....50-10-5%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	30-10%
Heavy	20-5%

RAWHIDE LACING—For cut, best grade, 45-5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45-5%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.59
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15@22	19.00	14.00
Colored	10.00@15.50	18.00	9.50

WIPING CLOTHS—Prices per pound in lots of about 600 lb., as follows:

	13½ x 13½	13½ x 20½
Chicago	$0.11*	$0.11*
New York	17½	....
Cleveland (*per thousand*)	36.00	45.00

*White, at washery.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.07	$1.21	$1.23

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	15.75	15.00	17.25	16.50
White	15.75	15.00	15.75	15.00

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅝-in. diam., 35c.; ½-in., diam., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:
New York.....$5.00* Chicago.....$3.50 Pittsburgh...$2.40@2.60

Boiler rivets, same sizes:
New York.....$5.20* Chicago.....$3.70 Pittsburgh...$2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in car lots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$47@52
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	22@27
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	26@31
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Chrome ore crude, 40@50%	net ton	18.00@19.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	65.00	50.00
(35% tin)	28.00	20.50	28.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$4.00	$3.80
Flats, squares and hexagons, per 100 lb. base	4.65	4.50	4.30

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	.....	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3¼ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$35.00 (net)	$ 52.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

		Lead Covered
Less than coil lots	50%	25%
Coils to 1,000 ft.	60%	30%
1,000 to 5,000 ft.	60–5%	35%
5,000 ft and over	60–10%	40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
½	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
¾	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$21.00
No. 16 cotton reinforced heavy	24.00
No. 18 cotton reinforced light	17.00
No. 16 cotton reinforced light	20.25
No. 18 cotton Canvasite cord	15.25
No. 16 cotton Canvasite cord	17.50
No. 16 super service cord or similar	75.00
No. 14 super service cord or similar	115.00

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30 amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60 amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0–30 ampere, standard package (500)	$2.85
0–30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs — Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled — Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1.25	1.35	24
				500	2.00	2.15	12
				750	3.50	3.70	8
				1,000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$6.85	$9.01	$10.60	$16.90
12	8.96	11.60	13.30	21.95
10	12.14	15.35	17.05	28.15
8	17.00	20.25	22.20	38.50
6	.....	.....	32.05	.....
4	.....	.....	43.69	.....
2	.....	.....	62.50	.....
1	.....	.....	84.15	.....
0	.....	.....	106.00	.....
00	.....	.....	128.00	.....
000	.....	.....	150.00	.....
0000	.....	.....	179.00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap — Key Each	Keyless Each	Pull Each	⅜ In. Cap — Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.35*	$0.39	$0.36	$0.39*
		.30*			.34*
		.28*			.32*

Less 1-5th standard package	30%
1-5th to standard package	35%
Standard package	40%

* Net.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Rubber tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%